ILLUMINATING ENGINEERING

SEPTEMBER, 1949

A Preview of Lighting Progress

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

NOW! for the Newest Most Efficient Fluorescent Light Source

New MAGNA-FLO 75"

Especially Designed for the NEW 8-foot, 75-w, T-12 Slimline Lamps!

More Light at No Extra Cost
. . . as much as 10% MORE!

Two Lamps do the Work of Four!
Instant Start! No Starters Needed!
Lower Operating and Maintenance Cost!

Modern streamlined lighting of factories and shops may now be obtained with these new individual Benjamin "Magna-Flo 75" Lighting Units or with the continuous lines of light of the new Benjamin "Lite-Line 75" System. These units use most efficiently the big, new Slimline 75-w fluorescent lamps—8 feet long, 1½ inches in diameter—which have a greater light output than any other fluorescent lamp.

Higher Efficiency

With Benjamin "Magna-Flo 75" it is possible to obtain from 7% to 10% more light on the working surface than is secured from the same wattage by other comparable systems. The lamps themselves give 10% or more lumens per watt. Two sockets take the place of four in this longer unit.

Lower Operating Cost

"Magna-Flo 75" operates with extra economy because there are fewer lamps to maintain—fewer lamps to replace. There is extra economy, too, in instant starting because no starters are needed and related maintenance problems are eliminated. The single-pin base construction of the new Slimline Lamps saves time in installation and replacement. New "Twin-Turret" heavy-duty lampholders are especially designed to lock these single-pin lamps securely in place and prevent their dropping out.

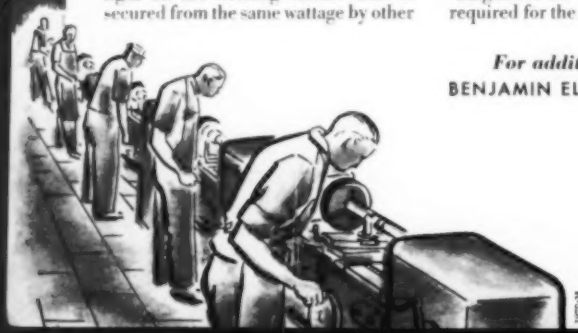
Extra Strength and Safety

"Magna-Flo 75" has the extra strength required for the most satisfactory operation of these big, long lamps. There is extra strength in the one-piece, heavy-duty channels, in the sturdy channel coupling and in the high quality porcelain enamel steel reflectors.

Benjamin "Life-Time"
Porcelain Enamel Reflectors

Benjamin Porcelain Enamel Steel Reflectors are standard equipment with "Magna-Flo 75". Porcelain Enamel is the ideal reflecting surface for the new Slimline Lamps. It has a high reflection factor (82%) and its diffusing characteristics help to improve the quality of the lighting and minimize glare.

Porcelain Enamel cuts maintenance costs, too, as it will not discolor or deteriorate under adverse atmospheric and operating conditions. Furthermore, its original high reflectivity is easily maintained by soap-and-water cleaning.



R-5251

For additional data send for Bulletin No. Ad 5612. Write:
BENJAMIN ELECTRIC MFG. CO., DEPT. I, DES PLAINES, ILLINOIS

BENJAMIN
"Magna-Flo 75"
FLUORESCENT LIGHTING UNITS
Distributed Exclusively Through Electrical Wholesalers

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

PUSH CONTACT
TWIN LAMP HOLDER

Key to Added Safety-Added Strength

IN WESTINGHOUSE INDUSTRIAL FIXTURES

New Push-Contact Twin Lamp Holders increase fixture quality—without increasing the price. Available now—as a standard Westinghouse Industrial Luminaire feature—they offer industries 6 maintenance-cutting advantages.

An all-steel housing eliminates socket breakage and chipping. Spring-type sockets, with beveled ring guides, are used at both ends of the fixture to make positioning and insertion quick, safe, and simple. Spring pressure at both ends of the lamp provides a "floating ride" for the lamps. They can't fall out—regardless of shock or vibration. Sliding action of spring contacts assures a safe, positive electrical contact. Starters, housed in the Lamp Holder, may be changed without removing lamps. An arrow indicates the lamp the starter operates. Smooth, one-piece construction allows easy, fast cleaning.

For complete information about the new Westinghouse line of Industrial Luminaires, featuring the Push-Contact Twin Lamp Holder, write for Booklet B-4194. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-04237

Westinghouse

PLANNED LIGHTING PAYS

. . . at BERRY-BURK & CO.
Richmond, Virginia

Architects: Marcellus Wright and Son
Consulting Engineer: Mr. George Wagner, V.P. of Morris Hunter Inc.
Electrical Contractor: Morris Hunter Inc
Lighting Equipment: Litecontrol No. 3234 troffer-type lens unit plus recessed lens boxes.
Lamps: 40 watt, white, fluorescent; 200 watt incandescent.
Wattage per fixture: 130 fluorescent; 200 incandescent.
Footcandles: 40-45 in service (average)

Shoe Sales Jumped

When they Relighted this Showroom

Increased shoe sales immediately resulted from this unusual lighting installation using Litecontrol fixtures. And the sales curve kept right on climbing for the ample, glareless light brought out all the sleek beauty of the fine footwear . . . made buying easier, selling easier.

Whenever *you* have a lighting problem come first to Litecontrol. You'll find every good type of fluorescent unit in this wide line of graceful, sturdy fixtures. Furthermore, you'll find our Lighting Engineers a real help in supplying unusual ideas and complete lighting layouts.

. . . with LITECONTROL NO. 3234 FIXTURE

Used so successfully in this installation is a strikingly simple recessed unit that gives efficient utilization of all the available light. Merely pushing up on the Holophane Controlescent ® lenses, and sliding them out, gives access to the inside for maintenance.

Cat. No.	Lamps	HOUSING Length	Width	Height	TRIM Length	Width	Approx. Weight
3224	2-40W	48"	11¾"	6⅛"	50½"	13⅜"	38 lbs.
3234	3-40W	48"	11¾"	6⅛"	50½"	13⅜"	43 lbs.

3200-3 End Cap; or 3200-6 Suspension Strap

LITECONTROL CORPORATION
36 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

LITECONTROL *Fixtures*

KEEP UPKEEP DOWN

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

SEPTEMBER
1949

Vol. XLIV
No. 9

A Preview of Progress 515
Light Sources 516
Street Lighting 525
General Technical 529
Color 536
Home Lighting 538
President's Annual Address — L. E. Tayler 548
Our Society in 1949-50 — Charles H. Goddard 550
Lighting Data Sheet—Series XIV
Lighting For a Food Shop (12-74) 553
A Photoelectric Brightness Meter — Yorick G. Hurd 555
Carlisle Room at NYU Demonstrates Lighting for Doctors 558
Is Lighting Saturation in Sight? — Samuel G. Hibben 561
Lighting Data Sheet—Series XIV
Cove Lighting for a Living Room (22-17) 565
Performance of Fluorescent Lamps on Leading Power-Factor Circuits — R. N. Thayler and A. Brownell 567
TELECAST—Lighting News of Current Interest 571
Sustaining Members 579
I.E.S. Publications 12A
Index to Advertisers 29A

G. Ross Henninger
Editor
Ruby Redford
Production Editor

Clayton E. Ellis
Advertising Manager

Publication Committee
E. C. Huerkamp, Chairman
Berlon C. Cooper
H. H. Magdsick
E. W. McKinley
Richard G. Slauer
Rudolf W. Staud
Francis I. Wilson

STATEMENTS and opinions in articles and papers in **ILLUMINATING ENGINEERING** are the expressions of contributors and do not necessarily represent the policies or opinion of the Society. Official Society opinions are expressed only in official committee reports specifically approved by the Council. Correspondence is invited on all controversial matters.

Published Monthly by the

ILLUMINATING ENGINEERING SOCIETY

A. D. Hinckley
Executive Secretary

Founded 1906

C. L. Crouch
Technical Director

PUBLICATION office 32d Street & Elm Avenue, Baltimore, Md.

EDITORIAL and advertising offices 51 Madison Ave., New York 10, N. Y.

ILLUMINATING ENGINEERING: The Journal of the Illuminating Engineering Society. Copyright 1949 by the Illuminating Engineering Society. Published monthly in the United States of America. Entered as second-class matter at the Post Office, Baltimore, Md. Acceptance for mailing at special postage rates provided for in Section 1103 P.L.&R. Act of October 3, 1917. Authorized July 16, 1918. ♦Subscription $10 per year plus extra postage to all countries to which second-class postage rates do not apply; single copies $1.50. ♦Address changes must be received at IES headquarters by the first of the month to be effective with the issue of the next succeeding month.

Curtis LIGHTING

engineered and designed FOR SELLING

That's the story that answers the trade's demand for increased sales. Sell "Lighting Engineered and Designed for Selling" to get a complete retail store installation . . . your assurance of customer satisfaction. It's a story backed by over fifty years of leadership in the lighting field.

Each of these Curtis units fulfills one of the four major requirements of retail store lighting . . . ATTENTION . . . INTEREST . . . DESIRE . . . ACTION.

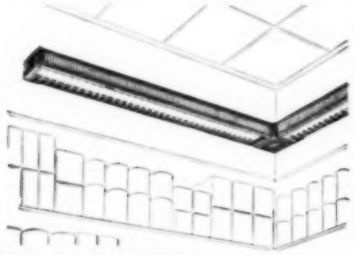
Get your share of this tremendous market with Curtis . . . "Lighting Engineered and Designed for Selling" . . . selling for you and your customers.

"Store-Liter"

Utilizing the new 75-watt, T-12, 96-inch fluorescent lamp. Features instant starting . . . more lumens per foot of lamp . . . 96-inches of uninterrupted light per luminaire. For general store illumination, it literally "washes the walls with light".

"X-Ray"

Silver-mirrored show-window reflectors for incandescent lamps. Three types: distributing, semi-concentrating, and concentrating. Creates "Attraction-Zone" lighting. Attracts more customers to merchandise displays.



"Punchy"

Utilizing one side-prong PAR-38, 150-watt projector flood or spot lamp. Adjustable from the floor to any angle 0° to 35° from vertical and 0° to 360° horizontal. Puts lighting emphasis where it is wanted.

"Wall-Strip"

Utilizing one 40-watt, T-12, 48-inch fluorescent lamp. Illuminates shelves, wall cases, etc., also directs some of its output to the ceiling where it is diffused into the sales area. Mounts to wall as individual unit or continuous run.

CURTIS LIGHTING, INC.
6135 WEST 65th STREET, CHICAGO 38, ILLINOIS
CHICAGO . . TORONTO . . NEW YORK

A Preview of Progress

IN KEEPING with this era of packaged goods, ILLUMINATING ENGINEERING presents in this issue a package representing a cross section of a year's significant developments and experiences in the field of lighting.

BEGINNING on the other side of this sheet and extending for another 31 pages is a series of informative digests reflecting the key thoughts and more important conclusions of 50 leading lighting authorities whose papers and addresses comprise the program of the Society's National Technical Conference being held this month at French Lick in Indiana. Each paper is individually treated. Among them, they reflect what a competent committee of reviewers considered to be the most important and representative developments of the year in lighting theory, lighting equipment, and lighting application practice.

LIGHT SOURCES is the general subject theme of a dozen papers, ranging from research reports on the evolution and characteristics of new materials to studies of performance as revealed under various operating conditions.

HOME LIGHTING problems and opportunities are dealt with by five formal papers and an equal number of forum discussions. Topics range from lighting for sewing to the television-viewing habits of John, Jenny, and Junior Public and the lighting requirements for comfort in this newest household occupation.

COLOR, in relation to seeing and in relation to the various psychological and other factors pertaining to its effective use with light for the creation of pleasant environment, is treated from several different points of view.

STREET LIGHTING plays an important part in public safety and economy, and comes in for its share of specialized consideration in four pages dealing with some of the current problems of design and practical application.

TECHNICAL TOPICS in wide variety, ranging from a study of brightnesses at the borderline between comfort and discomfort to the control of daylight at windows and an application study of a schoolroom lighting installation giving a hundred footcandles, are the especial concern of nine of the papers.

I.E.S. ACTIVITIES, which are intimately interrelated with the life and potential of the lighting field, are searchingly discussed; by President Lee E. Tayler, in retrospect in the light of a busy and devoted year; by President-Elect Charles H. Goddard, in prospect with definite objectives in view.

IN ADDITION to these previews of lighting progress, other articles and news reports of current interest are presented in the usual manner. In later issues most of the previewed papers will appear in full with discussions.

D. E. Elmendorf Kirk M. Reid

LIGHT

Metal Reflector Coatings For Filament Lamps

The authors describe the three main types of filament lamps containing built-in reflectors: (1) pressed-glass types known as PAR or sealed beam lamps, (2) blown-bulb types with outside reflectorizing coatings, and (3) blown-bulb types with inside reflector coatings.

In the pressed-glass type, the reflector and lens are accurately molded as separate pieces by pressing molten glass. The reflector glasses are cleaned and two pieces reflectonized simultaneously, face to face. The lens is sealed to the reflector during lamp assembly. Aluminum withstands the high temperatures involved in sealing the heat-resistant glass used for such lamps, while silver burns away near the seal.

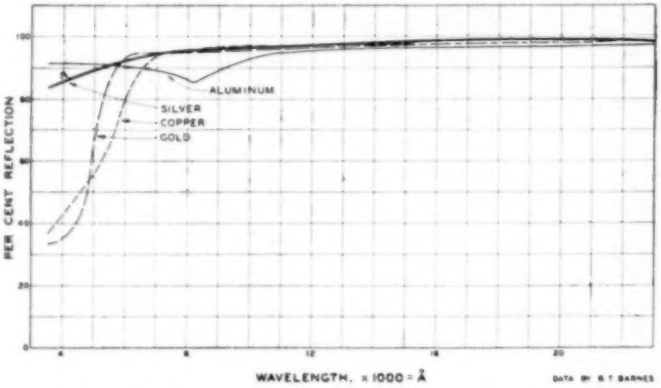
Blown-bulb lamps with *outside* coatings refer to silvered-bowl lamps and the like, where the reflector coating is applied after the lamps are completed. The largest processor of outside-coated reflector lamps employs a 3-step process: (1) a reflecting layer of silver is applied by a chemical solution, (2) a thin layer of copper is electroplated to the silver, and (3) a special aluminum paint is sprayed on and baked. The coating can be removed mechanically and configurations of reflector coatings obtained which would be difficult or impossible with an inside coating.

Blown-bulb lamps with *inside* coatings employ bulbs formed in a rotating mold by air pressure. The area of the bulb to be reflectorized usually approaches a paraboloid. The most popular is the R-40 bulb, while the R-30 has recently reappeared on the market. The former is made in lime (soft) glass and in borosilicate (heat-resistant) glass. Early laboratory lamps were made with silver reflectors chemically deposited inside the bulbs. For some years an inside reflectorized coating of vaporized aluminum was employed and more recently an efficient process for vaporizing silver has been developed. Data are presented to show that the use of silver represents a 10-15 per cent gain in total lumen output and maximum candlepower as compared with lamps using vaporized aluminum. For lamps with lower filament temperatures designed for heating purposes, silver is still superior to aluminum, though to a lesser degree. Vaporized copper in heat lamps has a reflectance slightly better than aluminum, but below silver.

The accompanying curves show the spectral reflectance of flat plates freshly coated by evaporation with various metals in a highly evacuated bell jar. These curves would indicate an increased light output of only about 5 per cent from using silver instead of aluminum. However, the process of dissolving the metal from the end of the bulb (to permit egress of light in the finished lamp), and subsequent washing may affect the reflectance of the remaining mirrored surface. The higher light-output ratio of silver to aluminum results because silver more nearly approaches its maximum reflectance, under present production processes.

Once it is sealed off in a lamp, silver can withstand a higher lamp operating temperature than aluminum. This is a particularly important point in many reflector lamps where it is desired to concentrate as much wattage as possible in a given-sized bulb.

In their paper the authors present cut-away views of a sealed beam headlamp, a PAR-38 projector lamp, a silvered-bowl lamp, a semi-silvered bowl lamp, and R-40 and R-30 reflector lamps. Also included are pictures taken by an electron microscope, showing greatly magnified surfaces of vaporized silver and aluminum.



Reflection of front-surface mirrors freshly coated by evaporation.

Authors: Lamp Development Laboratory and Engineering Division respectively, Lamp Department, General Electric Company, Nela Park, Cleveland, Ohio.

SOURCES

G. A. Freeman

G. Meister T. H. Heine

Low Pressure Mercury Discharges

The extensive use of fluorescent and bactericidal lamps has resulted in data being reported on low pressure mercury discharges in which a single inert gas such as Neon or Argon, and recently to a limited extent Krypton, is used in combination with the mercury. The paper reports information on the performance of mixtures of inert gases with low pressure mercury discharges in which one component is krypton.

The discharge tube used consisted of a special three-part bulb having a center section of ultraviolet transmitting Vycor and end sections of phosphor coated Pyrex. Electrodes were of the independently heated type. A matching three-part Vycor-Pyrex water jacket surrounded the tube making it possible to control the temperature of the bulb, and thereby the mercury vapor pressure inside, to the desired value. With the tube continually sealed to an exhaust system it was possible to operate the discharge in a variety of gases and gas mixtures throughout a broad range of pressures and simultaneously measure ultraviolet output, phosphor output, bare mercury arc light output, and electrical characteristics.

Authors: Westinghouse Electric Corp., Bloomfield, N. J.

The experimental procedure involved checking the output meters against standards, stabilizing the bulb temperature at 45° to correspond to about 9 9 microns of mercury pressure, reading the lamp values for the plain mercury discharge, then admitting the gas under investigation for readings at progressively lower pressures. Upon completion of the run the plain mercury discharge and standards were reread. This system was followed on the pure gases Krypton, Argon, and Neon and mixtures of Krypton with Argon and Krypton with Neon.

It was found that maximum ultraviolet and fluorescent efficiency occurred at 2 mm pressure for a 50% Krypton - 50% Argon mixture and for a 75% Krypton - 25% Neon mixture.

The voltage of the lamp was lowest at 2 mm pressure for all Krypton-Argon mixtures and also for Krypton-Neon mixtures below 60% Neon. For higher percentages of Neon the minimum shifts below 2 mm. The Krypton-Argon voltage-composition relationship is substantially linear but the Krypton-Neon relationship is not.

The arc efficiency for visible light was a maximum at 1 mm pressure for all Krypton-Argon mixtures and also for Krypton-Neon below 80% Neon. Above 80% Neon the arc efficiency was higher at 2 mm pressure.

With the 50% Krypton - 50% Argon mixture there was a minimum in the arc efficiency-composition curve for all pressure parameters. No such minimum was observed in the Krypton-Neon series.

Commercial type F lamps corroborated these experimental data. In addition they show the decided advantage over pure Krypton lamps of operating without striations at a lower ambient and bulb wall temperature.

Short Arc Mercury Lamps

Short arc mercury lamps are being developed in sizes of 5 to 10 kilowatts power and arc lengths of half inch or less which have brightness comparable to high intensity carbon arc. A pulse type starting circuit has been devised to automatically start or instantly restart lamps without relays or other moving parts.

Short arc mercury lamps of low power made years ago kindled a desire for high power high brightness mercury arcs that could not be satisfied with the then limited knowledge of the necessary materials. The development of high power lamps has been a battle of materials out of which practical designs are expected to emerge for commercial use in the near future.

The problems in materials that have been solved to a considerable extent are: first, the making of quartz bulbs of suitable size and strength to withstand high temperature and internal mercury pressure: second, the design of seals capable of carrying several hundred amperes current into a quartz bulb and yet not fail from extreme strain of widely differing coefficients of expansion and a wide temperature range of operation; third, the design of electrodes capable of carrying high current and of resisting too rapid disintegration from their proximity to the extreme temperature of the arc discharge; fourth, the development of a suitable operating circuit.

Concentration of high wattage in so small an arc results in a very high temperature at the electrode tips. Tungsten is used because it is the most refractory metal available. However, its melting point of 3370° is easily exceeded in attempting to obtain maxi-

Author: Westinghouse Electric Corp., Bloomfield, N. J.

Figure 3 of the paper. 10 kw a-c lamp with ¼-inch molybdenum rod seals.

mum arc brightness. The fact puts a ceiling on brightness until a more refractory electrode material is developed. Considering the rapid bulb blackening by operation at the melting point of the electrodes, the brightness is limited to about 500 candles per square millimeter or about a third the brightness of the sun.

Electrode designs are available for making either alternating or direct current lamps. The color of light from short mercury arcs has been found to have four or five times as much red as general lighting high intensity mercury lamps. It is, however, still deficient in red as compared with other familiar bright sources. Cadmium and zinc metals have been added to the mercury to increase red output since both these metals have spectral lines in the red region.

The 10-kw short arc mercury lamp is shown in the photograph and the important characteristics are given in the table.

TABLE III.—Tentative Characteristics of 10 Kilowatt Short Arc Mercury Lamps

Wattage	10 kilowatts
Supply	100-120 VAC
Rated average life (hours)	50
Maximum arc brightness (initial)	50 c/sq mm
Lumens (initial)	550,000
Arc length (millimeters)	10
Arc width to half brightness (millimeters)	5
Bulb diameter (inches)	4
Maximum overall length (inches)	20
Arc voltage	60-75
Arc current (amperes)	175
Maximum starting current (amperes)	300
Operating position	Vertical*

*Other positions with magnetic field or other means to prevent overheating quartz bulb.

In general, human activities take place in two basic "working" and "social" environments. The former includes such typical interiors as offices, schools, factories, some stores, and parts of the home. The latter encompasses restaurants, bars, lounge areas, lobbies, other types of stores, and other parts of the home. The usual psychological requirement for the working environment is that it be cool and neutral, while that for the social area be warm and stimulating. Either environment may or may not be critical with regard to lamp efficiency, or to color rendition of important environmental materials. For those actively engaged in lighting practice, this paper presents specific data on the statistically preferred sources for many common materials.

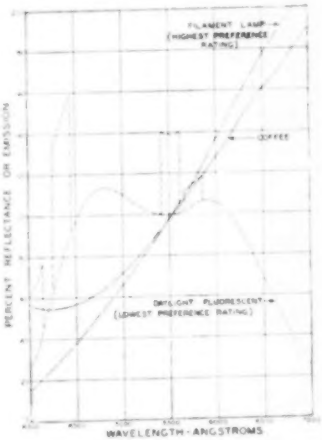
These studies reveal certain correlations between the source and object lighted. In general, the preferred source is that one most similar spectrally to the material viewed. That is to say, the daylight lamp was found to have a high preference rating on blue fabrics and materials, the warm tint on the yellows, 4500 white on white materials, the soft white on complexions and common foodstuffs, with filament equally preferred on foodstuffs. A typical case, that of coffee (with cream) is shown where the spectral reflectance of the coffee and the spectral emission of the most and least preferred sources for this material.

G. S. Buck, II

Color Preference Studies With Fluorescent Lamps

In the brief span of a few years, the inherent high efficiency and other properties of the fluorescent lamp have brought it spectacular success, yet, the vast color potentialities of this type of source, the first in which spectral distribution and color can be varied with relatively little change in efficiency, have scarcely been touched. In fact, the several "white" fluorescent lamps developed to date for general lighting service have largely been attempts to imitate prior sources, *e.g.*, filament or daylight, or have evolved largely from theoretical considerations. The objective of the series of studies summarized in this paper was to establish a rational basis for the development and application of "whites" that are functionally most effective and esthetically most satisfying.

Author: General Electric Co., Nela Park, Cleveland, Ohio.



Spectral reflectance of coffee with cream under two different sources.

filament and daylight fluorescent lamps are plotted to an arbitrary 100% at 5550°A, corresponding to maximum eye sensitivity. Some exceptions are noted and the possibilities of using mixtures of lamps to expand the color gamut are discussed.

For most applications some compromise is indicated, since several materials are usually of significance in the environment. However, some of these factors such as complexions and foods are not controllable, are frequently objects of attention, and are of unique psychological importance to the average human being; hence should be weighted heavily. Other factors, such as the materials of design: woods, fabrics, paints, wall and floor coverings, although they may individually not be viewed as critically, subtend a greater visual area and the harmony of the ensemble may be highly significant.

Comprehensive and systematic studies have been carried out in the laboratory, utilizing trained observers and with special facilities providing a great range in the colors and spectral qualities of illuminants. In order to obtain fundamental knowledge of the materials involved and their correlations with the illuminant, hundreds of spectral reflectance measurements were made of human complexions, common foodstuffs (prepared and au natural), of woods, fabrics, leathers, paints, wallpapers, carpets, flowers, foliage, etc. The complexion studies were considered of unique significance—because people themselves appear under all lighting installations — and were reported to the 1947 I.E.S. Convention at New Orleans.

Of equal importance were the checks obtained through the cooperation of approximately 2500 observers, including attendees at I.E.S. section and chapter meetings, several university groups, and people participating in lighting courses at the Lighting Institute at Nela Park. These people viewed about thirty typical critical environmental materials usually under seven sources.

The above concepts and studies are an important guide in assuring good color rendition with new designs of fluorescent lamps incorporating the new higher efficiency halophosphate phosphors.

The Determination of Color Parameters Of Fluorescent Lamps

By Charles W. Jerome

This laboratory has a spectroradiometer which automatically records the relative energy of any luminous source placed before its entrance slit as a function of wavelength. This instrument has proven itself extremely useful in many aspects of new phosphor development. A further piece of information which should be obtainable from the data furnished by this instrument is the color parameters for the I.C.I. color mixture diagram of fluorescent lamps computed from their spectral energy distribution curves.

For luminous sources having continuous emission spectra, these color parameters are easily computed. However, the similar computation for fluorescent lamps is complicated by the presence of two dissimilar types of emission:

1. A continuous emission from the phosphor coating.
2. The line spectrum of the mercury discharge.

Both of these emissions contribute to the color of the lamp and must be taken into consideration when measuring color parameters.

The color parameters for the phosphor emission alone is easily computed by the selected ordinate method. Therefore, the problem is the proper evaluation of the recorded energy of the mercury lines as compared to the recording for the continuous spectrum and expressing this value in the proper form so that it may be added directly to the summations of the selected ordinates used in the computations for the continuous phosphor emission.

Author: Sylvania Electric Products Inc., Salem, Mass.

A study of the passage of light through the monochromator used in our ratiometer, a Beckman spectrograph, indicates that a continuous spectral distribution of radiation will give a recording x times as great as for a monochromatic radiation having the same amount of energy per unit wavelength, where x is the effective slit width used in the monochromator. Since the slit width of the monochromator is held at 5 millimicrons at all times, and the mercury lines may be considered essentially monochromatic as compared to this slit width, the recorded energy of the mercury lines over and above that of the continuous radiation must be multiplied by 5 to put both types of radiation on the same basis.

In order for this value of the energy of the mercury lines to be added directly to the selected ordinate summations for the continuous spectrum, they must be considered as spread evenly over the interval between selected ordinates in which they occur. These intervals between selected ordinates are so selected that the product $x\Delta\lambda$ equals a constant, which is 3.560 when 30 ordinates are used and λ is expressed in millimicrons. Therefore, the interval between selected ordinates can be found from the above relation as:

$$\Delta\lambda = \frac{3.560}{x}$$

with similar expressions involving y and z.

Therefore, the final value for each

TABLE

Barnes Colorimeter		Computed Values		Barnes — Computed	
x	y	x	y	x	y
.309	.337	.299	.326	—.010	—.011
.314	.337	.310	.331	—.004	—.006
.353	.368	.355	.368	+.002	.....
.366	.366	.364	.363	—.002	—.003
.399	.387	.401	.386	+.002	—.001
.400	.398	.396	.395	—.004	—.003
.435	.401	.434	.408	—.001	+.007
.439	.402	.427	.406	—.012	+.004
			Average Deviation	—.004	—.002

mercury line to be added to the selected ordinate summations is:

$$\frac{5R_{Hg}}{\Delta\lambda} = \frac{5R_{Hg}x\lambda}{3.560}$$

with similar expressions involving y and z.

The table lists the values of the color parameters of a few fluorescent lamps computed by this method along with the color parameters of the same lamps determined on a Barnes Colorimeter.

R. H. Clapp

Thermionic Emission in Gas Filled Incandescent Lamps

The study of arcs in incandescent lamps is of especial importance to the consumer. There are two general types of arcs, one occurring as a result of the final failure of the filament, and usually occurring after hundreds of hours of operation, and the other occurring when a lamp is first lighted normally during production and before it has had a chance to burn more than a fraction of a minute. It is the cause, measurement and elimination of this latter type of arc that is the subject of recent investigations by the author.

It can be shown that while an increase in either the time or temperature of the so-called "flashing" procedure during manufacture can lower the tendency of the lamp to arc when subsequently relighted at rated volts, this change in "flashing" may have an adverse effect on the crystal structure and thus on the strength of the filament during transportation. Other means were therefore sought to lower this tendency to arc.

A direct correlation was found between the tendency of a given group of lamps to arc and the amount of thermionic emission given off by their filaments. Special measuring devices were set up for comparison of these emissions, and by this means it was found that the excess thermionic emissions which were present in the lamps having the greatest tendencies to arc were a direct function of the surface cleanliness of the filament. It was also concluded that internal impurities within the structure of the tungsten contributed to this excess emission.

Fig. 3 of the paper is illustrative of a typical set of thermionic emission data on a previously unlighted lamp. In obtaining these data, the lamp was lighted in five-minute steps starting at 40 volts and then progressing by 10-volt increments every five minutes up to 130 volts, at which voltage the lamp was allowed to age out for a period of three hours. The emission so obtained is shown as Curve A. The fully aged lamp was then re-run through the same voltage and time cycle to record the normal emission of the fully aged filament under the same conditions. This is shown as Curve B. The area between Curve A and Curve B represents the excess thermionic emission and is shown to correlate well with both the cleanliness of the filament and the tendency of the lamp to arc.

In the course of making these measurements, readings were also taken on filament temperatures and lamp currents. It was observed that in unaged lamps which showed excessive thermionic emission, the filament temperatures were abnormally low and the lamp currents abnormally high. After complete aging and remeasuring of these same lamps, normal thermionic emissions, temperatures and currents were found to exist.

A theory is proposed by the author to correlate the relationship of filament impurities, acting through the medium of thermionic emission, with the threefold effect of arcs, high lamp current (watts) and low filament temperature (lumens per watt).

Author: Sylvania Electric Products Inc., Salem, Mass.

J. H. Campbell

Special Circuits for Fluorescent Lamps

This paper describes some of the unusual fluorescent lamp circuits for special applications and a few of the many possible ways in which the lamp may be started and operated.

Many readers are acquainted only with standard methods employed in starting and operating fluorescent lamps and quite naturally are not familiar with the special applications or the possibilities of applying other methods of starting to gain advantages for general applications.

The author discusses a new circuit developed for fluorescent lamps as applied to motor coach lighting. The power supply is an engine driven alternating current generator designed primarily for charging batteries. The frequency of the generator varies with the speed and therefore a novel circuit was required to start and operate the fluorescent lamps. The end product is a ballast combination much smaller and lower in price than the conventional 60-cycle ballast. The attending photograph illustrates comparative size of the two ballasts for a 42" T-6 slimline lamp.

A weight saving ballast circuit employing a conventional glow switch starter is described. The special feature of the circuit is the capacitor ballast which may be used only at power line frequencies of 300 cycles or above. The capacitor ballast weighing only a few ounces is especially attractive in aircraft lighting, where a saving in weight is of utmost importance. In one such airplane a 400-cycle power supply is available, and the use of the capacitor ballast saved a total of 70 pounds as compared to 60-cycle ballasts. Other advantages of the capacitor ballast for fluorescent

Author: General Electric Co., Nela Park, Cleveland, Ohio.

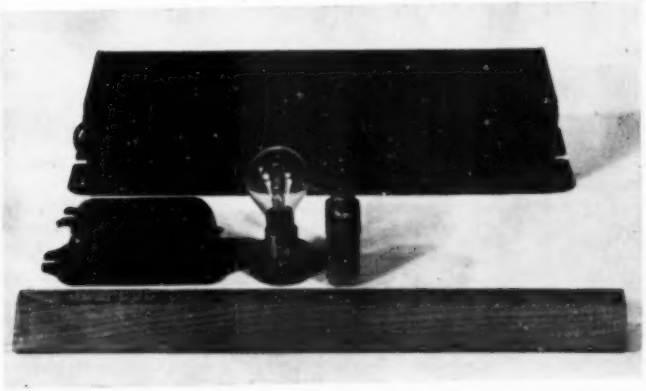
lamps are low cost, silent operation and higher efficiency. The author previously discussed the advantages of high frequency operation of fluorescent lamps in a paper published in ILLUMINATING ENGINEERING, February, 1948.

A circuit employing a split-phase ballast without auto-transformer operates four 85-watt lamps by starting each set of two lamps in sequence and operating them in series. A four-lamp ballast for 100-watt lamps employing the sequence circuit was used for lighting large industrial plants during the war. Considerable saving of copper and iron was accomplished in addition to other advantages which include a 50 per cent reduction in ballast loss, cost and weight. However, the use of the ballast was limited to 265-volt distribution systems which are not available in most plants today. The introduction of the krypton filled 85-watt lamp with its lower operating voltage may allow the use of this circuit on the more common 236-volt lines.

The author discusses starting and operating requirements of fluorescent lamps for series reactor and resistor ballast lamps. Present starting circuits require a voltage of from 2½ to 4 times the lamp operating potential if voltage is applied across lamp electrodes. However, if the gas in the lamp is ionized from an external source, the required line voltage need be no greater than the voltage needed for regulation.

The paper describes a system of starting by means of high voltage pulses applied to the glass bulb of the lamp or radiated to the lamp by means of a small metallic button. The ballast can be of the conventional choke or ballast lamp type, with a thermal or manual switch for starting. The ionizing pulses are provided by means of a very small pulse transformer, the primary of which is connected in series with lamp electrodes and the starting switch contact. Each operation of the switch produces a high voltage pulse which is transmitted externally to the fluorescent lamp by means of a metal contact or radiator located at the center of the lamp's length. The author points out that when cathodes are preheated a very small amount of energy is needed to ionize the gas and prepare the lamp for starting. The components of the starting circuit are therefore, small and light in weight. Since additional line voltage is not required to start the lamp, the minimum size of ballast can be used.

Advantages of some of the experimental circuits include self starting, simplicity, lower cost and silent operation. However, in many cases, widespread use of these circuits must await lamp adaptation to retain or improve present values of life, lumen maintenance and efficiency.



Comparative size of the two ballasts for a 42" T-6 slimline lamp.

George S. Evans

Low Temperature Performance of Krypton-Filled Fluorescent Lamps

Fluorescent lamps require use of a fill-gas in addition to mercury vapor for satisfactory lamp performance and life. Until recently, argon gas at a few millimeters pressure had been used exclusively although it was known that use of krypton gas would generally result in higher lamp efficiency. When krypton gas became available in the required purity and quantity at reasonable cost, it was used in place of argon in the 60-inch T-17 lamp to make the 85-watt T-17 type and in a new 33-inch T-12 lamp, the 25-watt T-12 type.

Several studies had been published on the performance of argon-filled fluorescent lamps at low temperatures. It was found that the new krypton-filled lamps performed sufficiently different from argon-filled lamps at low ambient temperatures that publication of the results of extensive low temperature tests would be desirable. This paper presents the results of such studies.

Data were taken on bare lamps operating in still air in a large thermally insulated room, the temperature of which could be varied from 0°F to 120°F. The lamp types studied were the krypton-filled 85-watt T-17 and 25-watt T-12, argon-filled 100-watt T-17 and 20-watt T-12, and a 25-watt T-12 utilizing a special krypton-neon gas mixture. Data taken at various ambient temperatures in the range of 0°F to 120°F included light output, lamp watts and volts, bulb temperature, light stability, and warm-up time. Curves are given showing how these lamp parameters vary as a function of ambient temperature.

Author: Westinghouse Electric Corp., Bloomfield, N. J.

A new technique, developed to test the relative startability of lamp types without use of glow-switch starters, was applied to compare the effect of krypton and argon on lamp starting. This technique consists of applying a voltage pulse, controlled as to amplitude and time, to a preheated lamp in such a way as to simulate glow-switch starting. Data were taken on the pulse voltage required to start the lamp types at ambient temperatures in the range 0°F to 110°F, and with different pulse times.

The operational tests disclose that the argon lamps perform much better at low temperatures than do the krypton-filled lamps. The latter do not maintain light output as well, and may have unstable light output ascribed to moving striations in the gas discharge. The krypton-filled lamps also require longer warm-up times to reach stable light output.

The starting tests show that argon-filled lamps are fundamentally easier to start. This need not be an important factor in selecting a lamp type for application, as excellent starting may be obtained with krypton lamps operating with the proper circuit components and starter.

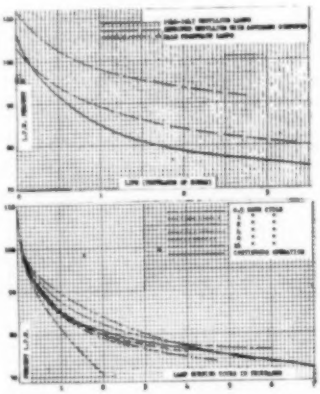
F. J. Vorlander E. H. Reddin

Performance of Fluorescent Lamps on Various Operating Cycles

Few factors are as important as time to fluorescent-lamp development engineers. Engineers searching for ways to extend lamp life realize how limiting 8760 actual hours of time available a year can be for testing such developments. Life testing often required one to two years while changes occur so fast that data obtained are usually of historical nature rather than applicable to current production. One effect of this time element has been to retard lamp development. Another important effect is that up-to-date information on lamp performance has been difficult to present in published form for consumer use due to the rapidly occurring improvements.

Several years of operating fluorescent lamps of popular sizes on flashing circuits of various flashing cycles revealed the probability that short-cycle operation of lamps of various construction types would indicate the value of such construction changes. It was believed from these data that by operating a group of lamps on a variety of operating cycles further data could be obtained which would prove the practicability of testing lamps on possibly 0.5-hour or 1-hour cycles and thereby greatly decrease the time required for testing new lamp developments. It was also considered that such data would enable the authors to provide a performance curve of burning cycles *vs* lamp life and lumen maintenance so that a consumer operating lamps on other than 3, 6 or 12-hour cycles could predict or anticipate lamp life for maintenance and group replacement purposes.

Accordingly, to test these theories, life racks were built to operate lamps on 0.5, 1, 2, 4, 8 and 16-hour burning cycles and continuously. Thirty-two lamps were operated on each cycle. The products of four lamp manufacturers were represented. Each lamp was photometered periodically for lpw maintenance throughout life. Lamp starts and lamp life were recorded. Starter and lamp operation were scrutinized twice daily. Line voltage was controlled. Commercial twin-lamp brick-type ballasts were used and their temperature and electrical output checked. It was the intention that these operating tests should duplicate the performance of well maintained high quality equipment in the consumer's use.



Upper set of curves show effects of 4-hour burning cycle on different lamps. Lower set show effects of different burning hour cycles on lpw for 1947 beryllium lamps.

From data obtained curves have been drawn which show that for burning cycles of one hour or longer the lpw maintenance is quite similar, but on 0.5-hour cycles the lpw curve varies from those of longer duration. The curve of lamp life *vs* lamp starts on burning cycles shows that for the one-hour cycle, the time required for life tests is approximately half as long as for 3-hour cycles. All data obtained indicate that life testing and accumulation of lpw maintenance can be greatly accelerated by operating fluorescent lamps on one-hour burning cycles. In this way the science of lamp development can be advanced.

To substantiate these test values, further tests were conducted on the same racks, as it is realized that this is but a start in what appears to be a progressive step. These new tests include lamps of new cathode construction and coating such as those which now have a 7500-hour average rated life, plus similar construction lamps coated with improved non-beryllium phosphors.

Lumens per watt curves show the gain resulting from recent lamp improvements. These lamps have shown greatly increased life over previous lamps on the short-time operating cycles and in a comparatively short testing time. The authors are sufficiently convinced that one-hour burning-cycle operation does accelerate the testing of new lamp developments, that new additional life racks for testing current production lamps in their plant have been built incorporating a one-hour rather than the 3-hour burning cycles operation.

Authors: Champion Lamp Works, Lynn, Mass.

F. W. Reuter, Jr.

Performance Comparisons Of Hot and Cold Cathode Fluorescent Lamps

For a number of years, instant-start slimline fluorescent lamps have been made in the same laboratory with activated hot cathodes and activated cold cathodes. Inasmuch as the same phosphor-coated bulbs have been used for both cathode-types of lamps, there has existed an excellent opportunity to study differences in construction, processing and performance of cold and hot cathode fluorescent lamps.

Lamps with activated hot cathodes are more efficient than those with activated cold cathodes, because less voltage at the cathode, or cathode drop, is required to release the electrons to maintain the lamp discharge. (In 96T8 slimline lamp sizes, the hot cathode is initially about 25% more efficient than the cold when operated at 120 ma). For any operational current from 100 to more than 300 ma, the hot cathode drop is 20 volts or less, and remains essentially constant throughout the life of the lamp. Voltage and wattage characteristics of slimline lamps with hot cathodes are, subsequently, constant throughout life at any given current. Life is not significantly affected over the recommended operating range from 100-300 ma. Somewhere below 100-ma operation, life diminishes rapidly, because the temperature of the self-heated hot cathode is not maintained, and the cathode drop rises above the sputtering potential of 20 volts for the active material on the cathode, which causes lamp failure. Sputtering of the cathode also occurs during starting for any lamp current which limits the life of slimline hot cathodes operated on multi-start circuits.

The initial cathode drop of the activated cold cathodes used in slimline lamps is about 85 volts. Sputtering of active materials is, therefore, continuous for all operational lamp currents. The cathode fall increases during life to 160 volts or more with consequent rise in lamp voltage, as illustrated in Fig. 2 of the paper for one test of cold cathode lamps operated at 120 ma. Operated below 60 ma, voltage rises are not significant until 10,000 burning hours are reached. Operational currents above 120 ma are not recommended because of the precipitous increase in lamp voltage early in life.

The voltage rise characteristics of fluorescent lamps having activated cold cathodes adversely affects the lumen maintenance as well as the wattage maintenance of lamps operated on lag ballasts with fixed voltage inputs. Life to lamp failure is nevertheless very long for the cold cathode lamps, even at the high operational currents, and is not affected by the number of starts.

High filling-gas pressures increase the life and per cent lumen maintenance of both hot and cold cathode slimline lamps, and extend the time beyond which voltage rise occurs in the cold cathode type, as shown in Fig. 2. Fluorescent lamps with low filling-gas pressures, however, have higher initial efficiencies and lower starting voltages; consequently, compromise pressures are selected for best over-all performance of slimline lamps, and not necessarily for the longest burning lives.

The lumen output of slimline fluorescent lamps of equal overall length is basically greater for those with hot cathodes because of their extra lighted length at the ends of the lamp; in 96T8 lamp sizes, this amounts to about 4 per cent. Test results of comparison cold and hot cathode lamps operated at 120 ma, have usually shown the initial (100-hour) lumens of the hot cathode lamps to be consistently higher than can be accounted for by their extra lighted length alone. This added variance in initial lumens between the two cathode-type lamps, is largely due to lowered efficiency of the phosphor-coating, caused by the severer exhaust conditions required to de-gas and activate the larger cold cathodes.

Cold cathode slimline test lamps having lumen losses due to the severer exhaust conditions, in general, have had better *per cent* lumen maintenance values. The total lumens delivered by each cathode-type of slimline test lamp, nevertheless, remained greater for the hot cathode type up to any equivalent burning life within the range of the hot cathode lamps.

Operated on 120 ma, the lumen per watt efficiency of slimline lamps depreciates faster with activated cold cathodes than those with activated

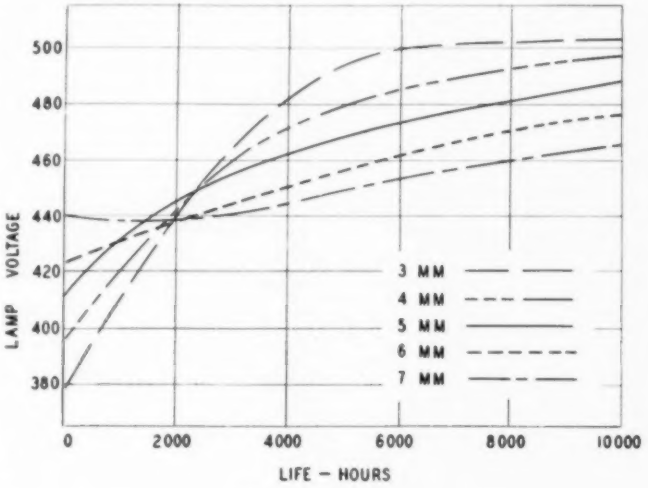


Figure 2 of the paper.

Author: General Electric Co., Nela Park, Cleveland, Ohio.

hot cathodes. At lower currents, this efficiency depreciation rate of the cold cathode lamps approaches that of the hot cathodes, and greatly exceeds it at higher currents. The comparatively longer life of the cold cathode lamps, particularly at low operational currents and on multi-start circuits, may, for some lighting purposes be more important than the efficiency alone. There is, therefore, a wide current range which can be served by either hot or cold cathode slimline lamps.

Humidity Effect on Instant Starting of Fluorescent Lamps

By Robert H. McFarland
Theodore C. Sargent

Instant-start circuits for initiating the arc discharge in fluorescent lamps are desirable from the consumer point of view but present more technical difficulties than the conventional starter-type circuits. The absence of an inductive surge or high voltage transient in the instant-start circuit makes it necessary to have a higher initial voltage potential to start the arc. External inhibiting conditions may interfere with the ease of starting. Humidity is a major example of such an inhibitor.

Controlled tests were run to indicate the extent of the humidity effect. 40 T12 lamps were selected, which were constructed under as nearly identical conditions as possible and whose normal low humidity starting potentials were alike.

The average AC cold starting potentials of the test lamps were measured and plotted against variable relative humidity. A similar group of readings was taken with absolute humidity as the independent variable. It is this latter group of curves which is most interesting for it shows most clearly the dependence of starting potentials on the temperature and humidity of the air to which the lamp is exposed. Increased absolute humidity produced increased starting potentials while increased temperature at constant absolute humidity over the range at which these measurements were made produced a decrease in starting voltage.

Surface resistance and starting potential measurements were made on a lamp under conditions such that surface resistance could be made to vary. For large surface resistances, this was accomplished by taking measurements in the humidity cabinet. Variation in humidity caused the necessary variation in surface resistance. Lower surface resistance conditions were obtained by immersing the lamp in solutions of different conductivities or by painting the lamp with conducting paints.

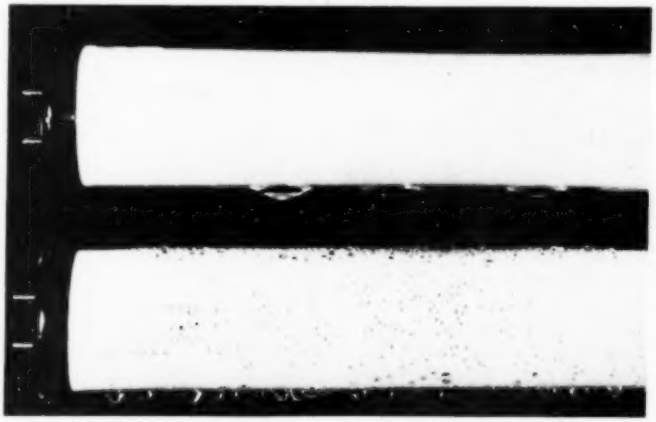
The data obtained are plotted with starting voltage versus surface resistance to form curve A of the accompanying illustration.

These investigations coupled with others in which lamps were started when immersed in liquids of different conductivities led to the following conclusions:

1. The humidity effect is caused by a water film being in direct contact with the glass envelope.
2. The moisture in the atmosphere between the lamp and the reflector has negligible effect if any at all.
3. The humidity effect causes a delay in the initiation of conductivity of the lamp gas.
4. The leakage from lamp pins, along the lamp, ordinarily has a negligible part in the humidity effect.

Since measurements made in a humidity box do not allow rapid changes of circuit or ready measurement of small currents and potentials, an experimental lamp was wrapped with numerous band of metallic foil which were separated from each other by small air gaps. By connecting the bands with various sized resistors, it was possible to simulate the effect of a capacitive coating with various values of conductivity such as is set by water on the lamp surface.

The close approximation of the banded lamp to one affected by humidity is shown by the curves. As previously stated, curve A indicates starting voltages versus surface resistance with varying humidity. Curve B represents the starting voltages which are obtained when the total resistance across the banded lamp is varied by changing the values of the resistors. The small departure of curve A from curve B is no more than would be expected between different lamps of the same type.



Comparison of the effect of humidity (moisture) on an untreated lamp (upper photo) and a silicone treated I.S. lamp (lower photo). Large drops collect on the untreated lamp surface. The hydrophobic silicone coating of the heated lamp has isolated droplets. The resulting high surface resistance is sufficient to minimize the humidity effect.

Authors: Sylvania Electric Products, Inc., Salem, Mass.

STREET LIGHTING

R. L. Bossard

Crest Roadway Lighting of Shasta and Grand Coulee Dams

In the years prior to 1930 the crests of dams constructed by the United States Bureau of Reclamation presented no particular illumination problem. The usual installation consisted of a ball globe and standard for local traffic or for operation and maintenance activities. However, following the year 1930 the Bureau of Reclamation has designed and built numerous major dams the crests of which frequently became a river crossing link in a highway of greater or less importance. Or if not included in a highway system, quite often the crest became a traffic way for visitors attracted by the features of the structure itself or for vacationists or sportsmen proceeding to recreation areas on the newly created lakes. It accordingly became necessary to provide a suitable lighting system for the safe movement of vehicles and pedestrians using these structures as traffic ways.

In searching for a suitable lighting system to meet these newer traffic conditions the previously used ball globe and standard installation was abandoned as being inefficient and unattractive. Hoover Dam, being the first large dam built after 1930, was equipped with the familiar fresnel lens viaduct fixture installed in the concrete parapets. Better architectural appearance as well as acceptable illumination resulted from the use of a low mounted fixture and numerous other structures were similarly equipped. Shasta Dam in California and Grand Coulee Dam in the state of Washington were no exception. They were different, however, in that structural railings were used on the crests instead of the usual concrete parapets. In these two installations attempt was made not only to have a low mounted fixture but to have the light source hidden from view as much as possible. This objective was accomplished by using the top rail of the roadway railings as a housing for an elongated lamp and by mounting a lens in a horizontal position on the under side of the rail.

Procurement specifications for the structural railings required that lighting fixtures be furnished as part of the top rail. The performance requirement of the lighting fixture specified only that the light output from the fixture be so directed upon the roadway that the maximum to minimum ratio of illumination should not exceed eight to one between a line midway between railings and a line six feet from the railings, and that the average illumination over the same area should be approximately three footcandles. Recent test data taken on the installation at Shasta Dam indicate an average illumination of approximately 3.3 footcandles and a maximum to minimum ratio of six to one over the previously defined area. Only the railings for Shasta Dam have been procured and installed at this time.

The lighting fixtures are continuous in both the upstream and downstream

Night view of the illuminated section of the roadway on the crest of Shasta Dam.

Author: United States Bureau of Reclamation, Denver, Colo.

railings and consist of an eight-foot slimline lamp in each ten-foot nine-inch-section of railing. An aluminum reflector aids in directing the light through a lens on the under side of the top rail. The lens is mounted in a gasketed hinged frame which is tilted eleven degrees above the horizontal. Figure 1 is a night view of an illuminated section of the roadway on Shasta Dam. The photograph illustrates the uniformity and general high level of illumination. The alinement of the roadway on Shasta Dam is on a large radius curve approximately 3000 feet in length whereas the roadway on Grand Coulee Dam is straight with a length of approximately 4100 feet. Both roadways are thirty feet wide between curbs with two-foot and five-foot nine-inch sidewalks on the upstream and downstream sides respectively.

Although the foregoing roadway lighting installations were made for a special condition of relatively slow moving traffic, still it is believed that similar installations might be successfully used when modified to suit the requirements of the faster moving traffic existant on bridges, viaducts, over and under passes, and on other special structures on our streets and highways.

D. M. Finch

Lighting Design for Night Driving

What are the engineering problems associated with lighting for night driving and are technical solutions available to meet these specific illumination requirements?

In this paper, the basic requirements for seeing under night driving conditions are reviewed and some solutions to the problems are offered. The loss in a driver's visibility at night alone constitutes a major problem for the illuminating engineer. But there are other factors perhaps equally important. Among these factors are driver comfort and fatigue which are influenced to a large extent by the glare sources in the field of view. Any attempt, therefore, to outline the basic design requirements for seeing conditions at night must start with an analysis of the existing roadway brightnesses and their patterns.

Author: Professor, University of California, Berkeley, Calif.

As a general statement the task is one of perceiving relatively large objects against a low brightness level background, usually with very bright lights near the object to be detected. The particular ability required of the driver is a good form sense and good minimum perceptible contrast. This requirement is not generally recognized since most tests of driver's vision are based upon visual acuity; that is, the resolution of detail at high levels of illumination. Actually, contrast sensitivity is the important factor, although visual acuity is not to be neglected. The minimum perceptible contrast between objects is discussed and is shown to be a function of the brightness difference between the object and its immediate background. Visual acuity is also discussed and is shown to be function of the minimum angle between two small detail parts of the scene that can be resolved by the eye. Both these factors are very much affected by the brightness level to which the eye is adapted. At high brightness levels one is able to perceive smaller contrasts and smaller detail than at low brightness. In order to show this effect and demonstrate it quantitatively, three typical situations have been analyzed. The first one is for a typical highway lighted by fixed luminaires. This roadway is reasonably representative of modern street lighting practice and is in conformance with the I.E.S. recommended practice for streets carrying large traffic volume. The second situation analyzed is that of an unlighted roadway which is illuminated solely by the upper beams of a modern automobile equipped with sealed beam headlights. The third situation is that of a typical room interior. The average adaptation level for each of these situations has been evaluated and the threshold values of minimum perceptible contrasts have been determined. If the ease of seeing is evaluated in terms of these threshold values the seeing in the interior room would be approximately three times as good as the roadway with fixed lights and approximately five times as good as the roadway under high beam headlight illumination. The visual acuity for these situations was also determined and it is shown that using typical fixed street lights, objects about twice as large as those of a typical room would be needed, and with headlights, objects about three times as large as in the interior room would be needed, to resolve the objects with equal certainty. The results indicate that for ordinary night driving conditions, very large objects are needed for distinct seeing.

The problems of seeing on the highways are further increased by the fact that the time for seeing is so limited. Data have been assembled to show that speed materially affects the visibility distance. The data are presented in graphic form which show how the visibility decreases with increasing speed for a fixed beam distribution. Data are also shown which would permit the beam distribution to be established for a given speed and visibility distance. Laboratory data have been assembled on the effect of light sources in the field of view which tend to reduce visibility distances. The effect of such sources is shown to be largely a function of the illumination and the eye from the source, the angle at which the source lies with respect to the line of sight, and the level at which the eye is adapted and empirical relationship of these variables has been determined. Using the techniques outlined in the paper, it is possible to compute a glare factor for any particular condition on the highway, and using the empirical relationship between glare factor and the surround, one can determine a surround factor which will give an indication of how the visibility conditions are reduced because of the glare sources.

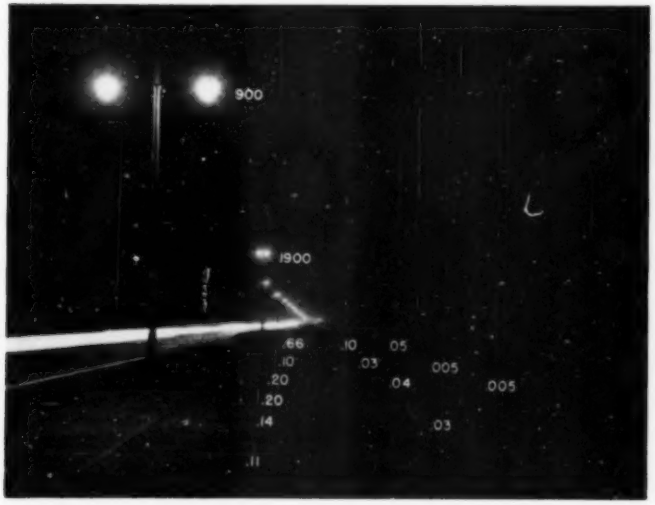
The tests covered by the paper indicate that for good seeing, it is neces-

sary to have the roadway clear of approaching lights or bright sources in the field of view; to have the roadway brightness pattern as nearly uniform as possible; and to have the average brightness level as high as practicable. These conditions will not only improve the actual visibility but will reduce the driver fatigue and the discomfort that is experienced under ordinary conditions.

For design purposes, however, it is necessary to consider more than just the physical aspects. The drivers have to be included, and their physiological as well as psychological reactions must be taken into account. Field tests have shown that because of driver inattention, and differences in experience and overall ability, objects are now seen at the same distance when they are expected, as they are when the observer knows that the objects are present.

A factor of utmost importance is that of the comfort of drivers when operating at night. Glare sources have been shown to be definitely uncomfortable when in the line of sight. The effect of glare sources is to cause distraction and to require additional nervous energy to compensate for their presence. If the brightnesses become excessive, the situation is actually reflected in irritation and pain. Laboratory researches on the subject have shown that a glare sensation is a function of the brightness at which the eye is adapted, the size of the source, the brightness of the source, and its position in the field of view. Analytical data as well as field data on a typical situation are given. These data show that illumination of 0.018 footcandle at the eye will cause objectionable glare, and the level of 0.11 footcandle at the eye will cause a situation corresponding to intolerable glare. These footcandle levels would correspond to a distance of 1040 feet for objectionable glare and 426 for intolerable glare for a typical vehicle on the roadway.

The overall design problem of the illumination engineer is thus outlined and the analyses are made of typical situations. Any given roadway seeing task can thus be analyzed to determine how it compares to threshold seeing conditions, how the glare sources affect vision, and how comfortable the situation is for the driver.



Fixed lighting, East Shore Highway, Berkeley, California. The numbers are measured values of luminosity in lumens per square foot. The streaks are traces of headlamps or tail-lamps. The chances of seeing a pedestrian on the edge of the roadway 350 feet ahead of a vehicle are shown to be very poor. The contrasts available are very close to the threshold values that can be detected by average stationary observers.

R. G. Slauer

Low-Mounted Fluorescent Sources for Highway Lighting

Low-mounted sources for roadways are advantageous under certain conditions. They can lead to the elimination of poles, saving in cost and improving daytime appearance. They depend very little on the reflection characteristics of road surfaces, and lose little effectiveness under fog conditions. Nevertheless incandescent sources have not been too successful thus applied because of the pronounced "shutter" effect to passing motorists and the difficulty of controlling glare because of high light flux concentrations in the field of normal view.

Fluorescent lamps, having such characteristics as high efficiency, long life and low brightness, are of obvious interest for roadway lighting applications. For overhead service their size which leads to more costly luminaires and a decrease in distribution efficiency must be balanced against the general results desired. Thus far more installations of this nature have been made abroad than here in the United States. However, size in the sense of linearity is not necessarily a handicap, since continuous or near-continuous fluorescent lamps may be a natural answer where low mounted sources are wanted.

The author has conducted a number of experiments along these lines. Included in this work were a rural road, an express highway, and several bridges. The latter led to a major trial installation on one bridge (500 feet of continuous slimline lamps for the illumination of a 32-foot roadway and 6-foot pedestrian walk). In general it may be said that visibility improves because of direct rather than pavement

Author: Sylvania Electric Products Inc., Salem, Mass.

Units mounted on the outside of a curve for danger-spot emphasis.

silhouette and that vertical as contrasted with horizontal illumination becomes the basic criterion of lighting effectiveness. Operating difficulties such as the accumulation of snow and the effect of low temperatures on fluorescent lamp performance can usually be overcome in a practical manner. The cost of continuous lighting on one side of a road where some structural element such as a fence is available for mounting is on the order of $25,000 per mile.

The author neither recommends for or against such lighting as a general solution for highway problems. It is very effective under certain circumstances; it may be inferior to other methods for general application. More important, this investigation emphasizes the tremendous possibilities still open for the general solution of roadway lighting — admittedly a difficult problem for the illuminating engineer. The necessity of directing light toward a long narrow area from sources which should not be disturbing under conditions of greatest variability and usually under strict budgetary limits still represents a major challenge. Continued research is needed for its solution.

R. M. Hoot

Photographs Truly Depicting Lighted Streets

"It's not a true picture of the lighting on that street."

How many times have we heard such a statement? Invariably a photographer employs his normal instincts when taking a photograph of street lighting. He wants to please his client. If it's a "before" shot he does not want the lighting to look too good and for an "after" shot the street must appear to be well lighted. Therefore the "before" photo is darker and the "after" photo is lighter than when actually seen. In extremely rare instances has the density of the finished print been checked with a photometer reading of the street surface shown in the scene photographed. The problem involved is to condense the wide range of eye adaptation (about 1,000,000 to 1) to the very limited range of photographic paper (about 60 to 1). (Lithography is about 40 to 1).

Yes, there is a method used by the British to obtain photographs truly depicting lighted streets which was discussed by Mr. Waldram at the New Orleans Conference last year but it is a rather complicated and much too laborious process. Sub-Committee No. 6 of the Street and Highway Lighting Committee was assigned the task of developing a more simple but just as accurate method. A method which any commercial photographer could employ without recourse to densometer's E and C and still use standard developers, filter and paper.

J. L. Tupper of the Densometery Laboratory of Eastman-Kodak in Rochester was assigned to work with the Sub-Committee to develop such a method and procedure. E-K's experiments of eye adaptation for night visibility during the war were of considerable assistance.

As a result of the investigations the "Tupper-Hoot Visometer" has been developed which when placed in the scene to be photographed provides a basis for the control of the development of the negative and for control of the finished paper print. After further experimentation it is expected that this control can be extended to lithography.

The Visometer is placed in the scene to be photographed and the intensity set at 2 fl. on the lightest area. The areas decrease in intensity on a logarithmic scale. Exposures are made on panchromatic film through a fairly dark green filter. An aperture of f4.5 is used. For low intensity areas (0.5 footcandle), a 10-minute exposure is made and for higher intensity areas (0.6 footcandle), a 5-minute exposure. The negative is developed in the standard way to a gamma of 0.8. All that is required in selecting the photographic reproduction which best depicts the lighted street is to choose the print in which the number in the test area disappears at the same step selected by the observer at the time of taking the picture.

From the results the many photographs taken and analyzed, your Sub-Committee believes that "photographs truly depicting lighted streets" are a reality.

Uncontrolled photograph showing the Tupper-Hoot Visometer in use.

Authors: Philadelphia Electric Co., Philadelphia, Pa., and Eastman Kodak Co., Rochester, N. Y., respectively.

GENERAL TECHNICAL

Application of Recommended Brightness Limitations to School Classrooms

F. C. Winkler John J. Neidhart

In the 1948 American Standard Practice for School Lighting, the maximum luminaire brightness limits shown in Table I are recommended. This paper shows the effects of these limits upon luminaire design and application and discusses their practicability.

One of the most popular fluorescent luminaires currently used for classroom lighting is a direct-indirect type for 40 watt lamps having a louvered bottom providing 30° transverse by 25° longitudinal shielding. Photometric tests show that both the 2 and 4 lamp 40 watt luminaires exceeded the higher limits set forth in the Standard Practice. Field tests on a two row installation of twelve 4 lamp, 40 watt luminaires indicated that satisfactory illumination uniformity across a 24′ x 30′ x 12′ classroom was obtained and that an average level of 50 footcandles may be maintained.

A common interpretation of the Standard Practice has been that 45° x 45° louvers are required to conform with the 0-45° zonal division of brightness limits. Such a louver was, therefore developed and a complete set of these louvers was made for the luminaires used in the previously discussed laboratory and field tests. The tests indicated that the 45° louver changed the luminaire distribution to semi-indirect (70% up) and made the downward component extremely narrow. The efficiency was reduced 15%, and the average maintained illumination level in the standard classroom was reduced from 50 footcandles to 42 footcandles. In spite of the 45° shielding, the four lamp unit exceeded the 2000 footlambert limit in the 0-45° zone, because the mutual buildup between lamps and adjacent reflecting surfaces raised the rated lamp brightness from 1884 to 2150 footlamberts at 0°. Illumination uniformity in the test installation was satisfactory, however, since the high upward component more than compensated for the narrowness of the direct component.

Actually, the Standard Practice does not specify any specific shielding angles. It merely limits brightnesses to certain values in three angular zones. The shielding required to conform with these limits can be determined only by extensive photometric experimentation. The resulting louver will have a variety of transverse shielding angles and will, therefore, be referred to as the X° louver. Use of this louver in the standard test unit resulted in a 10% improvement in efficiency over that obtained with the 45° louver; and the installation converted to the X° louver maintained 45 footcandles as compared to 42 footcandles with the 45° x 45° louver and 50 footcandles with the 30° x 25° louver. The luminaire still failed to meet the 2000 footlambert brightness limitation in the 0-30° zone because of the mutual buildup in lamp brightness previously mentioned. The distribution across the room was somewhat more uniform than that provided by the installation of 45° louvers.

Up to this point, only luminaires designed to conform with the higher brightness limits have been discussed. To satisfy the lower limits tabulated in Table IV of the Standard Practice, it was necessary to employ a translucent plastic bottom in the same luminaire design used for all louvered bottom tests. The maintained illumination level was 36 footcandles but is lower than the level provided by the installation employing 45° louvers only because of the increased dirt collection in a closed bottom unit. The illumination distribution was very uniform since most of the light came from the ceiling. However, many school officials feel that any advantages that such an installation may possess are more than offset by the increased maintenance problem —particularly where children are apt to toss paper wads, etc., into the luminaire.

Any I.E.S. Committee that attempts to improve the quality of lighting installations by establishing standards should be commended for its efforts and intestinal fortitude. Recommended brightness limits are bound to be subject to controversay, however, and the data obtained by the extensive laboratory field tests described in this paper indicate that some modifications of the rightness limitations may be desirable.

The major weakness in the brightness limitations stem from the fact that insufficient allowance was made for the mutual buildup in brightness between adjacent lamps and reflecting surfaces and from the fact that no tolerances for either the angular zones or the brightness values were included in the recommendations. The absence of any

Authors: Westinghouse Electric Corp., Cleveland, Ohio.

tolerance or smooth transition between angular zones results in the ridiculous condition that permits 2000 footlamberts at 44° and limits the brightness to only 900 footlamberts at 46°.

To provide a smooth transition between angular zones, it is suggested that brightness limits be expressed in the form of a smooth curve approximating the values recommended in the Standard Practice for all zones except the 0-30° zone where higher brightness limits are shown to permit the use of the currently popular and economic 4 lamp 40 watt luminaire in school classrooms. A further 10% tolerance on the curve values is suggested to absorb changes in lamp design, etc.

Merle E. Keck

Utilization Curves for Floodlights

The calculation of the average level of illumination for floodlighting installations is either very inaccurate or very laborious if conventional published methods are used. This is true because no simple method has been established for determining the percentage of the floodlight beam lumens which reach the area to be lighted.

The term "Coefficient of Beam Utilization" is suggested by the author to be included in the lumen formula for floodlighting calculations to express the percentage of the beam lumens falling on the area to be lighted. A method of determining the beam utilization of a particular floodlight has been worked out so that the time required to calculate the beam utilization for a particular floodlight used to light a particular area is only a few minutes. This method requires the use of a "Utilization Curve" for the particular floodlight involved which, once it has been prepared, may be used for any application of that floodlight. The principles and uses of floodlight utilization curves are similar to those for streetlighting utilization curves except that two variable dimensions rather than one are involved. The preparation of utilization curves for floodlights also must take into consideration the fact that floodlights, unlike most other types of luminaires, are not mounted in a fixed position but may be aimed in any direction. These factors have been taken into consideration in developing the proposed utilization curves which also present the required information in such a manner that computation of angles or trigonometric functions are not required.

The method of using the completed

Author: Lighting Engineer, Westinghouse Electric Corp., Cleveland, Ohio.

B. S. Benson, Jr. E. H. Church

The Effects of Luminous Ceiling Elements on Visibility

The purpose of this paper is to present the results found, and conclusions reached, from a study of louvered and paneled ceiling systems on the basis of visual tasks such as might be encountered in a small drafting room.

In embarking on such a study, the authors were cognizant of the fact that there are myriad visual task combinations possible in such a drafting room. For instance, the draftsman may use a pencil of any one of 17 degrees of hardness; he may use India ink with a wide range of line widths; again he may use colored pencil or ink. As a background for the above he may use drawing paper, tracing paper, vellum, or cloth which are available in more than 50 different types. In addition the draftsman may be required to read blueprints or blue-, black- or brown-line prints, sometimes directly and sometimes through a tracing medium. Since it was not feasible to investigate every possibility, a visual task was selected which was considered to be representatively severe. This consisted of viewing a black line print through a covering sheet of a typical tracing cloth.

Among the ceiling elements studied were several combinations included to see what effect reducing the brightness in the nadir-to-45° zone, for only that portion of the lighting system falling within the area that might possibly cause reflected glare, had upon visibility.

Readings with footcandle, visibility, and brightness meters were taken under carefully controlled conditions to offer a comparison between the various luminous ceiling elements and their combinations. The scope of the comparisons encompassed utilization efficiencies, visibilities, and the effects of direct brightness based upon Harrison's Glare Rating methods.

A further comparison was provided by means of the camera, with photographs taken of a number of visual tasks as might be found in a drafting room. These photographs, all taken along the observer's line of vision for the particular task involved, show graphically the results obtained and afford a visual comparison of the luminous ceiling elements investigated.

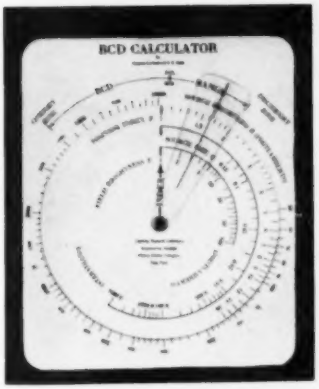
The results indicate that there was not a great deal of difference between the majority of systems investigated as far as visibility was concerned.

From the standpoint of per cent maximal visibility the 90° vane translucent louvers resulted in a better performance than the translucent panels throughout the scope of the tests. From the standpoint of reduction in visibility due to specular reflections, the 90° vane translucent louvers were slightly lower in performance than the panels in the zonule of possible reflected glare, but higher in performance in the zone of no reflected glare. The *average* reduction in visibility of the drawing board was less for the louvers than for the panels. The use of low brightness fluorescent lamps in conjunction with the 90° vane translucent louvers shows even more favorable comparisons under the conditions of the test.

Authors: Benjamin Electric Mfg. Co., Des Plaines, Ill.

curves is explained as well as an analysis of the accuracy of the several methods of computing average levels of illumination for a number of sports fields. The method of calculation and preparation of a floodlight utilization curve for any floodlight from a standard Photometric Test Report is described in an appendix to the paper.

The use of utilization curves to determine the Coefficient of Beam Utilization will permit the Illuminating Engineer to calculate anticipated footcandle levels for sports floodlighting installations much more quickly and accurately than was formerly possible. Comparisons between calculated footcandle levels and actual measured footcandle levels show that the accuracy to be expected by using these curves to determine the beam utilization is very high. It is a well known fact that the determination of proper Coefficients of Utilization for various sized rooms has enabled the Illuminating Engineer to use the Lumen Method for accurate interior lighting calculations of average footcandles. In a similar manner the simple determination of proper Coefficients of Beam Utilization should permit the use of the lumen method for sports lighting calculations of average footcandles.



From the quantitative results of extensive researches, a calculator has been devised for expediting analyses of brightness relationships which determine whether a visual environment is, or will be, comfortable or uncomfortable. This is one of 17 illustrations in the complete paper.

Brightnesses in Visual Field at Borderline Between Comfort and Discomfort (BCD)

M. Luckiesh S. K. Guth

The ultimate goal of lighting practice is to provide brightnesses in entire visual environment which produce the most satisfactory seeing conditions. This can be accomplished only by proper application of adequate knowledge pertaining to quality of lighting or what has been more broadly termed, *brightness engineering*.

This paper is a summary of the results of an extensive series of researches dealing quantitatively with the effects of sources of brightness in the visual field upon comfort and discomfort. Since only those who experience and pay the penalties of glare can appraise comfort and discomfort, the results are based upon subjective appraisals of sources exposed to view in a controlled manner amid a surrounding field of uniform brightness. The criterion was confined to the meaningful and practical sensation at the *borderline between comfort and discomfort*. This is termed the BCD sensation and the brightness which produces this sensation is the BCD brightness.

The relationships among the various factors which govern whether a visual environment is comfortable or uncomfortable are inherently complex. For convenience, these factors are divided into two groups. The first group involves those that are basic and fundamental such as

1. The brightness of the source or luminous area
2. The visual size of the source
3. The brightness of the surrounding field.

The relationships among these factors were determined by evaluating them in terms of the BCD sensation.

Certain other factors which have a modifying influence upon the basic factors include

1. The position of the source in the visual field
2. The number of sources in the visual field
3. The configuration of the sources.

The effects of the basic and modifying factors, as determined by a representative group of subjects, may be combined in the empirical equation,

$$M = \frac{B}{PF^{0.44}(Q^{-0.21} - 1.28)}$$

In this expression M is an index of the sensation of visual comfort when a source is exposed to view. It is expressed in terms of the brightness B, size Q and position index P of the source and the brightness F of the field or adaptation brightness. When M is equal to 108, the combination of source-brightness B, size Q, position index P and the field brightness F are such that the initial sensation of brightness received from the source is at the borderline between comfort and discomfort or BCD brightness. Smaller and larger values of M indicate departures from BCD brightness in the directions of greater comfort or discomfort, respectively.

The results of these researches have been reduced to a nomogram, and a disk calculator, shown in the accompanying illustration, has been devised to simplify the determination of the brightness conditions which should produce a BCD sensation of brightness for an average person and also for more sensitive individuals. Glimpses are given in the paper of the manner by which the basic and modifying data may be practicalized and rationalized into lighting practice. Seventeen illustrations are included in the paper.

Authors: Director, Lighting Research Laboratory, Lamp Department of General Electric Co., and Physicist, Lighting Research Laboratory, respectively.

H. F. Carroll W. B. Morton

Technique of Lighting Generating Stations

The paper deals specifically with the Pennsylvania Power and Light Company's new Sunbury Steam Electric Station. This is an entirely new project located along the Susquehanna river, near the City of Sunbury, in central eastern Pennsylvania that occupies 250 acres of land. The paper discusses the lighting, not only the power plant, but also all the interdependent buildings and areas that contribute to the efficient operation of the station; the million-ton coal storage area, Car Dumper building, Thaw Shed, Crusher House, Coal Transfer Station buildings, and the vast conveyor system; the Yard Service building, Control House, Substations, Offices and Shops and almost four miles of roadway.

Although the paper deals with an anthracite burning steam electric station, there are many problems that are common to all types of generating stations and it is believed that some of the solutions offered will be contributory to the solution of those common problems.

The ultimate objective of the illumination in this station was well defined from the inception of the station: That illumination be provided to operate and maintain that efficiency for which the station was designed. The problem of meeting the objective had somewhat of a parallel to Mr. W. C. Anderson's introduction to his paper on "Pole Foundations to Resist Tilting Moments" in which he stated "... then the depth of a neutral axis of a chosen foundation is found to be a biquadratic equation divided by a trinominal equation. These equations contain at least four variables, and with this indigestible beginning there is some temptation to lay the problem aside."

The first step was the coordinating of all forces for a complete understanding so that design and equipment would be consistent throughout the station. This problem was made easy through the cooperation of those forces. The use of a one-quarter inch to the foot model played an extremely important part in the actual design.

Since the keynote of the problem was efficiency, this meant that "cavern-effect," the twin brother to "Old-Man-Gloom," so frequently encountered in boiler rooms and steam electric stations, was dead. Indoor equipment was selected with extreme care so that some light would be distributed to the ceiling to facilitate the following of pipe lines, conducts and wires on cable trays quickly and easily and to create a more cheerful atmosphere. The equipment was also selected to reduce brightness differences so that the operator could see beyond a light source, when looking from one elevation to another, rather than being blinded by that source.

The requirements in the Control Rooms of the station and the Substation Control House were to provide a sufficient vertical intensity on the switchboards for efficient operation, without objectionable brightness reflections from the instrument faces, and to maintain pleasant working conditions.

The outdoor lighting had to be equally as functional as the indoor lighting; roadway lighting in accordance with the American Standard Practice, floodlighting for coal dumping areas, coal storage area and many other important locations, and substation lighting all for quick, safe and efficient operation.

The intensities vary in direct ratio to the many type areas and work done on a project of this type. To brief the subject; 25 footcandles was determined as a practical intensity for general illumination throughout the boiler room, coal crusher house, transfer stations and similar locations. In these areas incandescent lamps in prismatic glassware was selected for the desired quality and quantity of illumination. Fluorescent lamps in industrial reflectors are used in many areas, and in order to attain the desired upward component of light, apertures were provided in the top of the reflectors. These are used in the auxiliary bay where 25 footcandles is provided. Also in shops and service areas where 50 to 100 footcandles is provided depending on the work to be done in the area.

A 1:1 lumen ratio of mercury-incandescent illumination is installed in the locomotive repair shop, screen house and turbine room providing 50 to 60 footcandles.

Air view of Sunbury Steam Electric Station during construction progress, showing the magnitude of the lighting problem.

Authors: Pennsylvania Power & Light Co., Allentown, Pa.

In all cases luminaires are mounted as high as possible. Where equipment is mounted 25 feet or more, and there is no crane from which the equipment can be serviced, lowering type hangers are provided.

Ceiling mounted, continuous row, glass enclosed fluorescent luminaires are used in the offices providing a minimum of 50 footcandles.

After much study, louverall ceilings were selected for the control rooms and control house with exceptionally satisfactory results. The 50 footcandles of vertical illumination on the boards resulted in a horizontal intensity of 125 footcandles. The louverall ceiling is mounted at 11 feet with 3-lamp industrial reflectors mounted 2 feet higher on 3′ x 5′ centers. The lamps are switched so that 1, 2 or 3 lamps in each reflector can be placed in operation.

Prismatic substation units are installed in the switchyards in accordance with modern practice. Floodlighting is installed in those areas where necessary to take care of both normal and emergency operations. I.E.S. types III and V luminaires provide 0.4 ft-c along the roadway.

It is expected that some changes in the lighting system may be necessary when this station goes into full operation; however, they are not expected to be major in nature.

One conclusion can definitely be drawn; that approximately ½ of 1% of the cost of the project is not too much to pay for adequate quality and quantity of illumination for efficient operation and for the health, comfort, and welfare of the operators.

A New Automatic Recording Distribution Photometer And Simplified Calculation of Light Flux

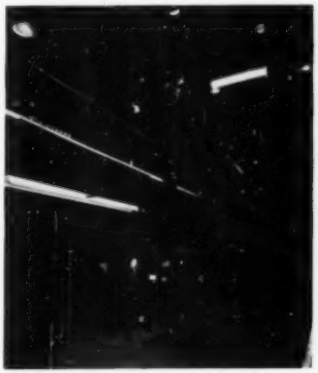
Geo. R. Baumgartner

In the relatively few years since the introduction of the fluorescent lamp more changes in photometric technique have taken place than in the period of over half a century between fluorescent and the inception of the filament lamp. Among the many improvements the following three are perhaps the most outstanding and deviate the most from former practice.

Visual photometry which had been used almost exclusively for measuring light distribution from filament lamps and lighting equipment was replaced by light-sensitive cells and indicating instruments. Not only was this true in the laboratory but also for portable light measuring devices.

There was a shift from direct current energy and storage battery banks to alternating current furnished through voltage stabilizers, regulating and filtering apparatus.

The third and most recent innovation is the use of automatic recording equipment for plotting light distribution curves which have effected savings in time and labor and have made feasible simplified calculations. A new equipment and a new simplified method of calculation are the principal subjects of this paper.



Photometer and cell in position.

Author: General Electric Co., Nela Park, Cleveland, Ohio.

Modern Photometry of Fluorescent Luminaires

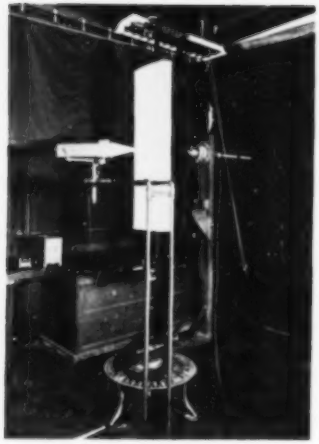
G. A. Horton

When electric lighting consisted of bare lamps suspended here and there in some simple form, illumination testing equipment was unimportant. As the practice of illuminating engineering advances, and with the development of new light sources, there is a constant demand for better and more scientifically designed luminaires having more efficient light distribution. As a result, complete and up-to-date laboratory facilities are now required in the design of modern lighting equipment.

The introduction of the fluorescent lamp several years ago provided a versatile tool for the illuminating engineer. These lamps provide high efficiency, low brightness light sources that are ideally suited for many applications. But like all other light sources, the fluorescent lamp should be used with properly designed luminaires to obtain efficient utilization of the light produced and to provide proper shielding of the light.

The fluorescent lamp as it is known today is a tubular lamp an inch or so in diameter and up to eight feet in length in the most popular sizes. Since any luminaire must be built around the lamp with which it is to be used, they are today built in sizes up to slightly over eight feet in length. The width of these luminaires depends on

Authors: Westinghouse Electric Corp., Cleveland, Ohio.



Brightness instrument in use on photometric bench.

of a room of ordinary height and proportions. The light output characteristics of fluorescent lamps are affected by air currents due to different positioning of the luminaires during testing. The photometer was designed in such manner that a correction factor could be obtained by thermally stabilizing the fixture in both measuring and normal hanging position.

The results obtained permitted photometric testing within the limits of accuracy of commercial photometry.

One of the most important measurements to be made upon luminaires is that of brightness, since brightnesses affect the visibility of objects and the comfort of the observer in sustained critical seeing.

The "I.E.S. Guide for the Photometric Testing of Fluorescent Luminaires—1948" (I.E. July issue) states that measurements should be made of the average brightness of a one square inch rectangular area of luminaire surface. A photoelectric instrument which could be approximately spectrally corrected to the standard visibility curve and calibrated by the relative method seemed desirable, rather than the usually uncorrected visual instrument which is calibrated empirically. An ordinary illumination measuring photocell was utilized, so shielded that it is illuminated by a portion of the bright surface having an area directly proportional to the square of the distance from the surface to the cell. This instrument is shown in the accompanying photograph.

Experience has shown the test results obtained with the described equipment to be sufficiently reproducible for commercial purposes.

the number of lamps placed in them, but they are usually less than eighteen inches, with overall depth seldom greater than eight or ten inches. This is in comparison with the heretofore conventional incandescent luminaire about eighteen inches in diameter and twelve to sixteen inches deep overall.

The practice of photometry is based upon the "point source of light" and the "inverse square law." It may be easily understood that the long, narrow fluorescent luminaires deviate considerably from a point source. The problem then, is the application of standard photometric procedure to this radically different type of luminaire.

Candlepower measurements should be made at test distances approximately five times the maximum dimension of the luminaire or at about forty feet for fixtures utilizing the eight-foot fluorescent lamps. To make these measurements by actually moving the photocell about the luminaire would require that it be mounted in the center of a room over eighty feet in all directions. This is rather out of the question in most cases.

The solution of the problem consisted of constructing a photometer which permitted of orienting the luminaire to any combination of horizontal and vertical angles desired with the photocell in the stationary position. The construction is of sufficient mechanical strength to handle the eight-foot luminaires and permitted the use

R. L. Biesele, Jr.

Daylight in Classrooms

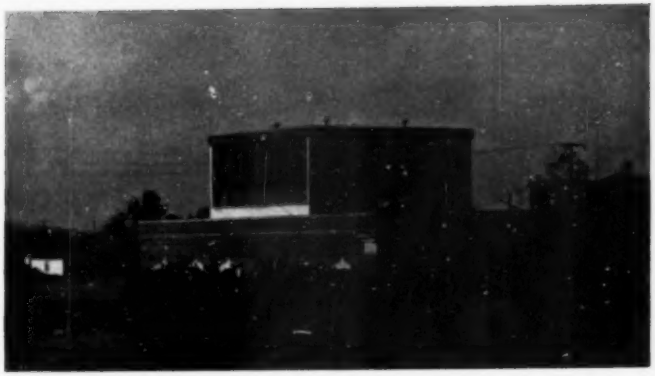
Since daylight is the primary light source in most classrooms, it is essential that the designer know the techniques available for its use in producing a beneficial visual environment. This paper describes an extensive study of the factors affecting the brightness patterns and visual environments in daylighted classrooms.

Tests were conducted in a building especially constructed for the purpose on the roof of the steam plant at Southern Methodist University, Dallas, Texas. The location afforded an almost unobstructed view of the sky in all directions. The 32 x 32 foot building has full window walls facing the cardinal compass points, and is equipped with movable ceiling and movable partitions.

The discussion in this paper has been confined to a 24 x 30 foot room with 12-foot ceiling, employing desks, room finishes, windows, various types of glass, shades, blinds, and other materials readily available at the present time. The discussion has been further confined to a unilateral lighting arrangement, primarily because unilateral lighting has been normally used in schools, and also because the solution of unilateral lighting problems has presented the greatest design challenge.

In the conduct of the tests it was found that there are two basic daylight designs of classrooms: (1) A condition of either clear or overcast sky with no sun on the windows; and (2) a condition of clear sky with sun on the windows. Vertical louvers were found useful on non-sun exposures in improving the brightness patterns in the field of view. They do this, however, at the expense of some reduction in useful light. The vertical louver is most effective for shielding out sky brightness under conditions of bright overcast or partly cloudy sky without sun. For conditions of sun on the windows: (a) white-painted fixed horizontal louvers tilted upward at 45° were found to give results comparable with the common Venetian blind; (b) white translucent shades gave good dif-

Author: Professor and Head, Department of Electrical Engineering, Southern Methodist University, Dallas, Texas.



Daylight experimental test house at Southern Methodist University, Dallas, Texas.

fusion; (c) a diffusing heat-absorptive glass used in portions of windows extending from 6 to 14 feet above the floor gave a satisfactory brightness pattern when installed in a western exposure, provided the sun did not get north of a line extending outward perpendicular to the windows and provided pupils are faced north or northeastward in the room; (d) a rolled prismatic glass was found suitable for non-sun exposures or for sun exposures if adequately shielded by horizontal louvers or equivalent.

A careful balance of reflection factors was found to be important in the decoration of the test room. Satisfactory results were obtained with a flat-white ceiling (85% RF), greyed-green walls (60% RF), and natural-finish pine floor (35% RF). The avoidance of excessive wall brightness was found to be necessary with all types of fenestration tested; also, the avoidance of excessive brightness ratios between the visual task and the darker areas and between window areas and adjacent wall areas in the test room.

The tests indicated that for all the window treatments reported on except one, the illumination on every desk had a value greater than the 30 footcandles recommended in the American Standard Practice for School Lighting, with daylight alone as the source of light. Illumination diversity was also found found to be surprisingly low, ranging, for example, from 120 footcandles on a desk toward the rear of the room and immediately adjacent to the window to 57 footcandles on the desk farthest from the window and at the front of a room under conditions clear north sky light and clear glass windows with no control.

The tests also indicated brightness ratios within the 0° - 30° and 0° - 50° zones to be within the recommendations of the American Standard Practice for School Lighting. In every case, for the normal "heads-down" or working position, the visual task was the brightest area in the 0° - 50° field.

It is apparent from the tests that a good daylight design correlating properly the seating, decoration, and window treatment, and employing commercially available materials, can produce visual environments which fully meet the recommendations of the American Standard Practice for School Lighting over a wide variety of outside light conditions. Furthermore, such environments can be produced with a unilateral lighting plan, which is the most economical arrangement for many schools. What is perhaps even more important, if such design for daylight is incorporated in the original architectural design of the building, it can be had at little more, if not at no added cost.

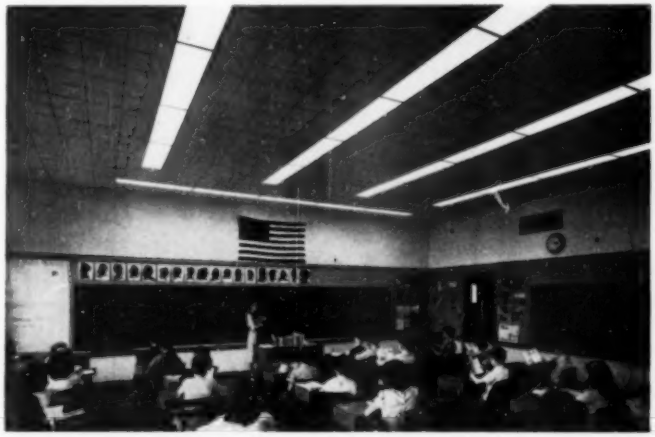
D. Z. Mozes T. R. Anderson

One Hundred Footcandles In a Troffer Lighted Classroom

In the discussion of this subject Bureau of Reclamation Engineers and Architects were designing two school buildings, one of which was a new structure and the other the re-building

Continued on page 547

Authors: General Electric Supply Corp., Spokane, Wash., and Bureau of Reclamation, Grand Coulee, Wash., respectively.



Columbia Basin Project, Grand Coulee Dam. Classroom in Central School showing recessed fluorescent lighting.

COLOR

Isay Balinkin

Introduction to Color

The art and science of illuminating engineering has entered into a more difficult, though vastly more promising field of activity, when the incandescent light sources are being rapidly replaced by various types of fluorescent luminaires. With these new light sources, an illuminating engineer is facing not only the problem of providing sufficient number of lumens per square foot, the considerations of economy, glare and other technical problems. He is also facing the problems of *color*, and the scientific understanding of what are the factors which determine the appearance of an object should be carefully studied.

It is perfectly obvious that such study should begin with the light source. Not only the sum-total effect of the light emitted by the source, but more specifically, its spectral energy distribution must be known. Thus, for example, two light sources may appear to be identical when viewed directly, yet there may be a marked difference in the appearance of various colored substances illuminated by one or another of these light sources. In some instances, which will be demonstrated, a relatively small change in spectral energy distributions may cause a shift in color from green to reddish brown.

Similarly, the basic information in regard to reflecting or transmitting characteristics of an object should be carefully studied by determining the spectrophotometric reflectance or transmittance curves. The spectral information of a light source together with the spectral behavior of an object should provide the illuminating engineer with two necessary elements leading to the evaluation of color.

The third link in the chain is more complicated because it involves a human observer and a manifold of conditions under which human mind will interpret the radiant energy received through its sensory mechanism. In order to simplify color evaluation, the International Commission on Illumination has replaced an observer by a set of standard response curves which again under specified conditions will establish color equivalence. Color match is achieved when the numerical values of the trichromatic coefficients are found to be equal. From the formalistic standpoint such equivalence may be all that is required and in many practical color calculations such information serves a useful end. It will be the explicit purpose of several demonstrations to indicate how important a further consideration of the conditions of viewing are. Thus, great differences in color can be brought about, even though the light source, the modifying substance and the observers remain the same.

Author: University of Cincinnati, and Cambridge Tile Mfg. Co., Cincinnati, Ohio.

D. B. Judd

Color Terminology

The illuminating engineer is the connecting link between the company selling electric energy and the public that buys it in the form of radiant energy.

Author: Colorist, U. S. Department of Commerce, Washington, D. C.

He is the expert on the construction and use of the light source, or luminaire, whereby electric power is converted into radiant power. Radiant power is simply the time rate of flow of radiant energy, and sometimes (as in germicidal lamps and sunlamps) the radiant power within certain wavelength ranges is a direct measure of the usefulness of the source to the consuming public. But by and large, the illuminating engineer, as his name implies, deals with radiant energy for the purpose of seeing. Radiant energy evaluated in accord with its capacity to produce visual sensation is light, and the illuminating engineer shows the public how to buy and use light to best advantage.

The usefulness of a light source is primarily measured by the amount of light flux it can deliver, but scarcely less important is the spectral distribution of the emitted energy which determines not only the color of the light source, itself, but also the colors of objects illuminated by it. In nearly every installation, the illuminating engineer is held responsible for the color effect produced by the lighting system. He is handicapped in fulfilling this part of his duties by the fact that his customer usually does not have an adequate language to describe either the desired color of the light or those of the objects illuminated by it, or perhaps the illuminating engineer speaks one color language and the customer another.

Now some satisfactory color languages are available (perhaps too many, and too little understood), and the consuming public and the illuminating engineer must eventually learn the same language. The customer requires the production of a definite color effect or appearance. He is therefore interested in the perceptions of the colors. The color perceived to belong to a light source may be described in terms of brightness, hue and saturation; that belonging to an object, in terms of lightness, hue and saturation. Brightness of the source-color perception varies from very dim to dazzling; lightness of the object-color perception varies from black to white.

A table is given in the paper, listing four sets of terms that are used alternatively. The first relates to the ICI standard observer and coordinate system for colorimetry; this set may be evaluated directly from the spectral composition. The remaining three sets may be determined from the ICI parameters (Y, x, y). Of these Munsell hue, value and chroma correlate most closely with hue, lightness and saturation of the object-color perception provided the observer be adapted to daylight. If the customer asks for a window lighting installation that will show up a red textile with a very high saturation, the illuminating engineer could design window lighting supplemented by a spotlight giving the textile a Munsell notation 5R 5/18 and be sure that the resulting color perception would prove to be very satisfactory. Because of the close correlation of the Munsell notation with the perceived colors of objects, illuminating engineers will be well repaid by learning this notation thoroughly.

Producers of pyrotechnics and luminous-tube advertising signs would no doubt like to know how to express the colors they produce in such a way that, for example, the notation of two self-luminous blues would indicate immediately which would be perceived as the more saturated color, and by how much. This would be very important design data because it would indicate pretty directly how much more the customer would be justified in paying for the one than for the other. No such color notation for self-luminous areas has yet been devised; there is no Munsell notation for lights. Perhaps the Inter-Society Color Council could develop one if it is important enough.

Related terms describing energy, color, and appearance

Physics	Psycho-physics	Psychology
Radiant energy	Luminous energy	Appearance

Terms relating to sources and flow of radiant energy

Radiant flux	Luminous flux	a. Brightness
a. Radiance	a. Luminance (photometric brightness)	
b. Irradiance	b. Illuminance (illumination)	
c. Radiant intensity	c. Luminous intensity	
Spectral distribution	Chromaticity (dominant wavelength and purity)	Chromaticness (Hue and saturation)

Terms relating to objects reflecting and transmitting radiant energy

Spectral reflectance	Luminous reflectance	Luminous reflectance		Munsell value	Lightness
Spectral transmittance	Luminous transmittance	Luminous transmittance		Munsell value	Lightness
Spectral selectivity	Chromaticity coordinates (x, y)	Dominant wavelength, Purity	Ostwald hue	Munsell hue	Hue
			Ostwald purity	Munsell chroma	Saturation

Ralph M. Evans

Some Aspects of Vision And Illumination

As Chairman of the Sub-Committee on Fundamental Aspects of the Psychology of Color, of the I.E.S. Committee on Color in Illumination, Mr. Evans will present a portion of his one-man report on the psychological problems facing the committee. The report as a whole will deal with many phases of visual psychology as it relates to illumination. The portions selected for this talk are those most in need of illustrative material and careful presentation. Basically, they all deal with the subject of contrast in the illuminated environment.

He describes the effect called "color" as being purely a mental effect growing out of the sensations recorded by the eye, an effect beggaring description in words. Of the 500 most frequently used words in the English language, only 15 relate in any way to vision, and of these only five are concerned directly with color. The author distinguishes between form-vision and color-vision and will demonstrate that for the most part what an observer sees depends as much upon the ob-

Author: Eastman Kodak Co., Rochester, N. Y.

Continued on page 547

HOME LIGHTING

Gladys Miller Janet S. Reynolds

Color and Light In the Home

The small home embraces an environment for rest, work, play and companionship. The use of color and light in this home is a complex subject. It includes suitable building materials and their economical distribution; efficient and understanding use of skilled and unskilled labor; better design to include adequate space for living, sleeping, eating, food preparation, and for current and seasonal storage. The successful performance of color and light in any room should not be obvious, but should blend in with pleasing effect and without the mechanical operation being evident.

The conditions created and given us by Nature have been the criteria by which most of us have lived for years, consciously or subconsciously. People, like Nature herself, feel the need for change. Nature accomplishes this with the four seasons, and the effects of these seasonal changes upon the growing things around her. People, on the other hand, accomplish these changes differently. The man or woman in a warm climate may dress in orange, red or other "warm" colors, but very often they turn toward the cooler shades in home decoration such as greens and blues with only a few accents of red or orange. Contrarily, the person in a cold climate, accustomed to bleaker and colder skies may be interested in warming up the residential interior with large areas of warm beige or rose, with accents of green or blue.

No longer do we think of a house in terms of room patterns. The living room, dining room, bedroom are fast becoming obsolete. We think of areas and, in allocating functions to those areas, we analyze the habits of the individual members of the family. The home we now visualize is designed to give each member, individually or groupwise, the four things which psychologists consider necessary: security, self expression, satisfaction and socialization.

To meet rising material and labor costs, the size of the average home constantly is decreasing. In twenty years the average $10,000 house has decreased from 2,000 square feet to 900. Space in the home, and its maximum and flexible utilization, has become a challenging problem for the experts to study and solve. Color and light properly used help give the impression of space. To be attractive, the colors in an area must harmonize and function as intended 24 hours of the day. We must know more about the effect of light, natural or electric, not only upon colors but upon colors distributed in different areas of the room and in varying quantities. We must know more about the physical and emotional effects of color on individuals and groups.

Compared with the past, the existing home is more conveniently lighted than any in history, but this record is poor considering that with the proper application of knowledge and equipment already available, our homes could be more efficient and more attractive. The fact that one out of every five school children has defective eyesight also indicates, to some degree, that our homes are inadequately equipped for health. Unfortunately, few homes utilize color and light correctly by the known standards, because the cost often is considered relatively out of proportion.

There are limits to the capacity of a given room to hold color, light or design. As our standards for better light have been raised, it becomes more difficult to light a room adequately with portable lamps without the number of lamps becoming obvious and distracting. The time has come for a greater acceptance and use of cove, spot, niche, valance, and cornice lighting.

Just as the lighting specialist needs to know more about the use of color in a room, the decorator needs to know more about simple lighting installations within the financial probabilities of home ownership, and both need to know more about the effects of filament and fluorescent lamps upon individual colors and color combinations. The small-home owner must be given sources from which he can purchase the materials that will give him the color and light he needs.

A way must be found to assemble and correlate the experiences of decorators, designers, and lighting specialists of unusual ability who instinctively use new materials, colors and ideas—without fully recognizing why or how. The study of the relationship of light and color must be continued, because color and light are essential parts of everyday life.

Authors: Decorator Consultant, New York, N. Y., and Home Lighting Consultant, Sylvania Electric Products Inc., New York, respectively.

A. W. Kakilty

Laundry Lighting Requirements

The "requirements" herein indicated refer to lighting in the residential laundry or the area in which the housewife "does the family wash." The problems involved relate to those in reference to just what the lady "has to see," how difficult and prolonged may be the visual task and what, if anything, can be done within the normal limits of the ordinary home.

The author, not having done too much of the family wash at home, encountered some surprises. The problem was originally attacked in the usual commercial fashion of supplying fair general lighting over the entire room area. But while this practice, as usual, is good and should never be discounted, still it was found that in the low ceiling areas in which washing is frequently done (such as a basement) the operator is quite apt to be always working in his or her own "light."

Other problems were:

a. Where is the washing now done? (Basement, Utility room, Kitchen)

b. With automatic washers the housewife reads dials instead of looking at clothes. Is not vertical illumination here more important than horizontal illumination?

c. Isn't the critical seeing task at the ironing center rather than in any of the washing operations?

Visibility meter readings were taken to serve as estimates of the seeing requirements. These ranged from about 5 footcandles in ordinary loading of an automatic washer to 27 footcandles in reading dials. In the ironing section, however, tasks ranged from 9 footcandles requirements to just see to handle clothes on a flat plate ironer clear up to better than 100 footcandles to detect slight scorches under certain conditions.

Some of the conclusions reached were:

1. Light colored walls and ceiling desirable for diffusion of light to all parts of appliances.
2. Area lighting (*i.e.* lighting the washer, the ironer, etc.) more important than room lighting.
3. Light required varies considerably. Most severe seeing task at ironing area. Probably the presently established kitchen lighting rule of ten footcandles general with a minimum of forty footcandles over certain working areas applicable here.

Author: Duquesne Light Co., Pittsburgh, Pa.

With ordinary lighting layout, operator casts a shadow on laundry devices.

E. W. Commery Mary E. Webber

Lighting for the Piano

The objectives of this paper were:

1. To ascertain illumination requirements for the piano score, and thus to supply the basis for including footcandle recommendations for pianos in the Illuminating Engineering Society's Table of Recommended Illumination Values.
2. To establish and locate a rational test plane area and to recommend limits of illumination variation on it.
3. To appraise existing luminaires most frequently recomended or used for this application in terms of objects (1) and (2).
4. To suggest ideas for design development which, based on these studies, promise improved lighting conditions for the pianist.

The procedures include visibility measurements of various musical scores with the Luckiesh-Moss Visibility Meter.

The examination of a wide range of both Grand and Spinette pianos shows that one principal test plane location for the music itself may be employed. Likewise, a single test plane location may be employed for the keys. The details of these locations are included in the paper. The extent of the music score is taken as a plane 18 inches wide and 12 inches high. Areas 9 inches wide are added to both the left and right hand sides of the music to indicate the extent of supplemental lighting for scanning additional music and for visual contrast relief.

Detailed measurements of illumination and observations of brightness patterns were made from the illumination supplied by 14 different types of

Authors: General Electric Co., Nela Park, Cleveland, Ohio.

lighting equipment. These included equipments most commonly used for the lighting of pianos and piano scores, and also included some that are proposed for the first time by the authors. The paper contains a comprehensive summary table of these illumination values and observational comment which covers each of the 14 individual tests.

Test data and results obtained show the need for more design development of portable equipments which more completely satisfy both the lighting and esthetic conditions of piano lighting. Up to this time there has been no objective statement of the requirements involved. This paper supplies such a statement. The paper presents a new table of recommended footcandles for piano scores. The values supplied are intended to provide visibility that is comparable when following the Society's recommended values for reading books or papers as set forth in the "Recommended Practice of Home Lighting."

Recommended Footcandles for Piano Scores

Grade of Piano Music (classification)	Recommended Illumination Level (minimum)
I. Elementary	10
II. Intermediate	20
III. Advanced	40

The authors, in addition to summarizing the results obtainable from such types of lamps as the 300-watt torchieres, 300-watt swing-arm lamps and various tubular equipments, conclude with three design proposals for new devices. One is a new design of table lamp to be used in pairs, having a new type of shade. The shade employs a 2-inch wide vertical section which permits a high percentage of the light to escape toward the music rack, and is so arranged that its brightness is not evident to the performer or other occupants of the room.

The second proposal has to do with the rack-attached unit in which a 21-inch fluorescent tube of small diameter is used to provide better coverage and a more delicately scaled unit.

The third proposal employs a projector bulb placed in an ornamental or decorative urn type vase in back of the music rack. The light is projected to the ceiling and is then returned by reflection from precisely placed small mirrors to both the music rack and the keys.

Myrtle Fahsbender Priscilla Presbrey

Lighting and Seeing Conditions for Hand Sewing in the Home

The authors have tried to determine (1) what lighting conditions are most desirable for hand sewing in the home, and (2) what types of available equipment will most nearly provide these conditions.

Of the tremendous variety of sewing tasks included in the many types of sewing done in the home, it was necessary for test purposes to standardize on some simple process. The task chosen was the ability to see a short section of running stitch, done with matching thread and a stitch length of ⅛ inch, on a few materials covering a wide range of reflectance values and degree of specularity. In the absence of color contrast, the chief factors enabling the eye to distinguish a stitch from its background appear to be differences in the specularly reflected light reaching the eye from the thread and from the cloth, and minute shadows cast by the thread and by slight ridges resulting from the tension of the stitches. These effects of course vary greatly with the brightness of the light source, the glossiness of the cloth and of the thread, and the pile of the material. However, even with totally indirect light, and with cotton thread and smooth, dull-finished cloth, they make some contribution to visibility. Obviously, then, the angular relationships between the working surface, the light source, and the eye are of great importance in determining the ease with which a sewing task of this nature can be seen. Under certain circumstances a change in the angle at which the light strikes the work can readily effect a greater improvement in visibility than a considerable increase in footcandles.

For this reason it is not possible to establish for these sewing tasks any simple relationship between visibility measurements and footcandles required to produce a given visibility level. Nevertheless, visibility measurements of the standard samples have been made at four illumination levels, with three types of lighting: totally direct, totally indirect, and a fifty-fifty combination of the two.

Although the results of these measurements were not sufficiently consistent to establish accurate visibility-levels for the specific sewing tasks, certain conclusions were indicated: With shiny materials, specular reflection from bright sources affects visibility adversely, and therefore totally indirect illumination is the most desirable. With matte-surfaced fabrics, totally indirect illumination was found to be much less satisfactory than either direct or direct-indirect. In general, for most sewing tasks illumination with at least some directional component is to be preferred.

In order to make possible an effective comparison of the lighting performance of available equipments that might be suitable for hand sewing in the home, it was necessary to establish some definite test area on which measurements could be taken. The previously-established 10- by 10-inch plane, tipped 45° from the vertical, seemed satisfactory for size and angular tilt. A consideration of the variation in the eye heights of seated women, in common furniture dimensions, and in individual sewing habits, made it obvious that the height at which the work is held varies over a wide range. A distance of 30 inches from floor to center of test plane was chosen as a working average, although by no means representative under all circumstances.

A variety of lighting units were then tested for the footcandle level produced on this plane, uniformity of illumination over the plane, and the ratio of the direct and indirect components. All tests were made in a standard test room. The results of

Authors: Home Lighting Department and Commercial Engineering Department, Westinghouse Electric Corp., Bloomfield, N. J.

these measurements on various common types of portable lamps and ceiling fixtures are reported in the complete paper, together with an appraisal of each luminaire as to its acceptability for the purpose.

In summary, it may be stated that Certified (CLM) lamps used singly under the conditions specified, produce a range of 30 to 100 footcandles (average) on the established test plane, with approximately a ten-to-one ratio between test plane illumination and general lighting level in the room. Higher values than the 100-footcandle range are difficult to obtain from acceptable and available diffusing sources such as CLM lamps, fluorescent fixtures, or their equivalent. When higher levels are desirable, as is very often the case, it is therefore necessary to resort to the use of concentrating equipment. Reflector and projector lamps, mounted in the ceiling or located near the task, are a practical and convenient means of supplying from two or three hundred to several thousand footcandles on a small area. Obviously, with such values of local illumination, sufficient general room illumination from other sources should be added to prevent excessive brightness contrasts.

E. W. Commery

Visual and Lighting Problems of Television

The impact of television upon the American family is not completely foreseeable. However, thousands, even millions, of families are experiencing the terrific dominance of television in their homes today. Its force changes almost every family routine for many weeks after a new receiver is installed. Now each evening, as darkness comes on, all lighting habits of the past are swept aside and the family attends the movie or the theatre at home. This association "demands" dark surroundings even though the television receiver be viewed in the earlier daylight hours.

That the motion picture and the television picture are different is brought out by the two brightness scales and the visual interpretations the viewer finds with each. A dark house is needed with motion pictures to maintain low visual adaptation. Bright outdoor scenes have to be created with screen brightnesses at values around 5 footlamberts. A considerable range of dark gray and black values are presented at values ranging from 0.01 to 0.05 footlamberts. Modern television receivers produce a scale of blacks to whites at ten times and more these values. Television blacks begin around 0.2 footlambert and may still appear to be black at over 1 to 2 footlamberts, while whites may begin at points between 5 and 10 footlamberts and go on up to values approaching 100 footlamberts. This real difference in absolute scale of values illustrates the substantial difference that exists between the motion picture and television. Without some background or surround lighting, the latter produces direct vision discomfort glare.

The discomfort-producing quality of television pictures may be visualized directly by viewing the picture for periods of 5 to 10 minutes in an unlighted interior. The benefit of surround lighting is easily demonstrated with a 60-watt lamp placed back of the receiver and moved away from the wall a foot or more so as to expand the background lighting pattern. With a variable resistor in the lamp circuit, the background brightness can be adjusted through a scale of values. This arrangement illustrates that the actual value is not critical. However, when the background begins substantially higher than the average brightness of the picture, this background pattern produces a sensation of discomfort. This, however, can be eliminated by lowering the value and adding some over-all room lighting. Switching off the background and room lighting produces an annoying visual shock. That nothing is lost in the television picture when viewed against background lighting is simply illustrated by switching the background lighting off or down in steps to off. While techniques have not yet been devised for evaluating or relating eyestrain for long, sustained periods of viewing to other known factors, average surround brightnesses back of the picture of not less than one tenth of the background tube brightness appear to be a reasonable compromise between the measurable and unmeasurable variables.

Under picture-size discussion, a viewing distance of 10 times the picture tube diameter in inches is recommended for the average and larger sizes of tubes. To this distance an additional foot or two is suggested to

The value of back lighting the television picture is easily demonstrated with a 60-watt lamp and variable resistor. The viewer may raise and lower his background brightness over sustained periods of viewing to gain this experience. The value of narrow trims around the picture to minimize the dark framing is illustrated in this case. Lighter finished equipments also aid the visual condition.

Author: General Electric Co., Nela Park, Cleveland, Ohio.

not only aid in fusing the horizontal trace pattern but to also eliminate the minute surface disturbances that often occur and interfere with visual equilibrium. This rule of distance supplies a better sense of being in focus for the more distant elements of scenes that are not always presented with the best definition or in a good range of tones. This distance rule may not be applied to extremely small tubes since only a general visualization can be obtained from them beyond several feet.

A "best-picture" setting of the contrast and brightness controls is suggested for each channel. This position can be determined by the lighting specialist through the use of brightness readings of the black, white, and a gray scale of the station's test pattern. The changes in both absolute and relative values of the gray scale of typical receivers shows the possibility of obtaining "best-picture" settings of these controls.

An extensive analysis of viewing filters is presented. The particular conditions under which these offer advantages to the viewer are set forth. All filters lower the brightness scale of the entire picture, and a similar lowering of the brightness control of the set does not provide a comparable result. Filters are usually employed to lower picture brightness when there is direct-view discomfort glare, which in turn is induced by the lack of background surround brightness or to reduce the "wash of blacks" due to too much incident light on the picture tube face. Each of these faulty lighting conditions can usually be eliminated. If present tube brightnesses could be increased several-fold at no marked increase in receiver and tube cost, the use of filters could be employed more generally to permit greater freedom of the placing of the receiver in rooms both day and night with respect to the amount of light that could be permitted to strike the tube face.

Examination of viewing lenses indicates essentially no reduction in brightness of picture. However, the position of the viewer is reasonably critical if distortion is to be avoided.

The basic principles of creating good visual conditions with lighting are presented in a number of illustrations. Creating background brightness patterns with a minimum of light striking the tube face is the essential point of design. New values for the brightness of shades for portable lamps and semi-indirect floor torchieres are included. These values range between 10 and 20 footlamberts—a range about one tenth that of current practice.

In conclusion, the author states that it becomes very clear that the desire for a dark room and the complete shunning of light here and there must be largely a mental attitude. When this mental attitude is adequately conditioned by repeated viewing of television programs in properly lighted surroundings, the dark room becomes a condition that is avoided more often than it is sought. It will undoubtedly take an intelligent program of some years to bring this one basic idea into the understanding of the American family.

Edith Buchholz

Appropriate Lighting for Today's Farm Home

With the extension of electric power to rural areas, the problem of adequate lighting for the farm home has received increased attention. Thus the object of this study is: (1) to show the need for adequate lighting in the farm home, (2) to show a variety of lighting applications which are practical for the farm home and within the financial reach of an average farm family, and (3) to summarize the lighting results in terms of their adequacy in providing for the home activities of the farm family.

Basically the principle of providing adequate general and local light for the seeing task being done, applies to any home—rural or urban. However, the activities in the farm home are generally variant from that of the city dwelling, thus the lighting requirements are somewhat different. The rural home not only fills the need of shelter, but it is the business office for the farm. It may also provide work space for preparing poultry or dairy produce for market—and generally there are extensive facilities for preserving and storing almost a year-round family food supply. In addition a place for family recreation is important since community and commercial recreational facilities are often miles away instead of only a few blocks.

In an effort to show the lighting needs and desires of the farm family, a typical farm home was selected for "re-lighting." This owner-operated farm consists of 160 acres. The farming operation would be classified as general with emphasis on dairy and poultry enterprises, and with a sufficient cropping program, including some rental land, to support the stock. The family of four includes two boys—ages 8 and 15. The home was originally wired with two circuits, but a year ago an additional appliance circuit was installed for the kitchen convenience outlets. Therefore, existing circuits are adequate.

The principal lighting problems here are typical of many farm homes—namely:

1. glaring bare light bulbs;
2. too low a level of general illumination;
3. inadequate local light—sometimes improperly placed;
4. inconvenient switch control, or in some cases complete absence of switch or pull chain control.

The family activities requiring "seeing light" were analyzed, and footcandle readings were taken of existing lighting facilities. For economy, existing lighting equipment was remodeled when possible, instead of being replaced. Two floor lamps of the bare light bulb variety were modernized by use of the white indirectlite, thus increasing the quantity and quality of their light output. One was returned to the dining room where it furnished local light for reading and book work and the other was shifted from the living room to the guest bedroom upstairs. New portable units were selected for the living room to supplement two diffusing

Author: Home Lighting Department, Westinghouse Electric Corporation, Bloomfield, N. J.

bowl lamps already there. These purchases included an inexpensive certified (C.L.M.) table lamp as a replacement for a too short decorative model, and a torchiere for general room lighting in the absence of a ceiling fixture. Clip-on plastic shields or louvers, as well as adapters, corrected the glaring light bulbs in utility room and basement recreational and egg cleaning areas. This left a more generous amount of the lighting budget for the purchase of permanently installed fixtures for the living areas of the home. Switches were installed in all bedrooms to control the ceiling fixture or a convenience outlet. Previously the bare bulb canopies on the 6' 11" ceilings had been controlled by adjusting the bulb. One convenience outlet in the living room was also wired for switch control.

Although this is the story of only one farm, the lighting applications could be translated to other types of fam homes. Tenant farmers, with the prospect of periodic moves, would naturally make greater use of portable lamp and adapter equipment. On the other hand, operator-owned farms being initially wired for electricity and lighting, will have even greater flexibility in the placement and selection of fixtures, and somewhat less of a remodeling or adapter job. For the most part, the average farm family judges a product or convenience in terms of the job it does for them. Its authentic decorative design or period styling is only a secondary consideration. Thus the keynote of the lighting plan, in keeping with the simplicity and decorative scheme of the farm home, is "Easy See-ability."

Aileen M. Page

Rooms with the New Look

Breathes there a woman so unimaginative, so devoid of interest in the beauty and comfort of her home that she never has said, "I'm so tired of this room! I wish I could make it all over!" If so she is surely in a minority group. The desire for change and improvement of her own and her family's environment keeps the alert homemaker aware of decorative trends. It keeps her interested in all new materials and equipment which contribute to greater ease and pleasure in carrying on her all-important function of homemaking in its finest sense.

To provide this comfortable, cheerful, colorful environment, lighting and decoration should go hand in hand. To illustrate this, seven rooms featuring decoration and/or lighting improvements have been selected for discussion in this paper. These include several budget levels and five types of rooms, and it is believed that all would satisfy that so normal feminine desire for complete change accompanied by equally essential *improvement* in comfort, livability and appearance.

Paint, fabrics, color and rearrangement of furniture have played important roles in the "new look" given these rooms. These changes will be obvious. Not so obvious to the untrained eye, perhaps, but of even more importance in the overall effect of the rooms are the lighting improvements. This is as it should be, for the purpose of good lighting is (1) to provide a comfortable, cheerful appearance and "feeling" in a room—to call attention to the *room* and not to the lighting; (2) to provide for the visual tasks light that is "soft," smooth, and generous in quantity, surrounded by room lighting that is in comfortable ratio to local light—again with emphasis on the task and not to an unpleasant degree on the equipment itself, as would be the case

At right — Unbelievable as it is, this dispiriting furnished room was converted by means of paint, lumber, fabrics, good hard work and good lighting into the gay and happy living room-bedroom shown below.

Below — Knowledge of lighting and interior design principles, skill with a needle and a speaking acquaintance with hammer, saw and paint brush accomplished the transformation shown here.

Author: Home Lighting Specialist, General Electric Co., Nela Park, Cleveland, Ohio.

if unshielded or poorly-shielded light sources were prominent in the visual field; (3) to emphasize decorative interest centers or art objects without undue emphasis on the lighting equipment.

This does not mean that all light sources should be concealed, for many cannot perform to best advantage under those circumstances. Neither does it mean doing away with fixtures and portable lamps. Quite the contrary, it usually means additional lamps and fixtures, but selected from the standpoint of lighting performance, appearance and eye-comfort, not from unlighted appearance only.

Homemakers today see many illustrations of both new and made-over rooms in which new color schemes, fabrics, wallpaper and rearranged furniture have been specially featured. The results as pictured are most appealing — cheerful, colorful, convenient in furniture arrangement. In photographing these rooms, particularly in color, the deficiencies in the lighting system have in many cases made it necessary to fill in with strong floodlights and daylight in order to show fabric texture, furniture and color to best advantage. Though unintentional, this is an insidious form of deception, for the average reader is completely unaware of the fact that it is the photographer's floodlights, plus daylight, and not the room's own lighting equipment that shows up the colors and fabrics with daylight effectiveness. The evening effect without benefit of floodlighting can only be imagined by the experienced lighting specialist, and too often the rooms would be extremely disappointing — drab, dull and uninviting compared to the illustrations.

The photographs of the "Rooms with the New Look" show as nearly as is possible in a photograph the actual *lighted* appearance of the rooms. Unlike many of the above-mentioned photographs which feature fabrics, furniture and color only, these rooms would be much *more* attractive in the evening than the most carefully-taken photographs could picture them. Rooms lighted according to today's recommended practice have a subtle atmosphere and "feeling" about them which no camera lens can capture. That is one of the extra pleasures resulting from "new look" lighting in one's own home.

Perhaps most dramatic of all the "new looks" provided by combined lighting and decorative design for the rooms considered in this paper, is that of the room pictured here. With such a depressingly drab start the results achieved seem miraculous, especially considering that the cost was kept to $110. The young woman whose ability, imagination and hard work made possible these results was Miss Beth McCrone, a Home Lighting Consultant on the Pacific Coast. Attractive as were the homemade furniture (desk, bookcase, coffee table) slip covers and draperies and the whole color scheme, much of the dramatic quality and comfortable livability of the room would not have existed without careful planning of the lighting, both functional and decorative.

The finished room provided three comfortable reading or study locations, and each reading lamp contributed to comfortable general lighting. The fixtures were simply the old rosettes revamped by suspending on small wires interestingly-shaped pieces of Masonite, through the centers of which 100-watt silvered-bowl lamps protruded to provide diffused, shadow-free lighting. Decorative, but still a part of the general room lighting was the valance, lighted with lumiline incandescent lamps as a "budget" measure in this temporary home.

Perhaps this room's complete rebirth is unusual because, fortunately, most rooms have more personality to start. However, it is certainly true, as the other six "new look" rooms will prove, that when the woman who makes over a room coordinates well-planned lighting with decorative changes she will be much more pleased with the results than if she had overlooked this subtle but very powerful means of assuring real comfort, convenience in function and enhancement of the decorative scheme.

Mary E. Dodds

Television Viewing Habits Revealed by Survey

Television, a new component of daily living, creates with its use an amazing number of questions. To the present time answers to the questions necessarily fell into the guesswork class. Now definite answers based upon technical knowledge and survey begin to replace the fallacies of the guesswork. These answers come from work such as a study recently made by an I.E.S. committee.

Under direction of the Residence Lighting Committee of I.E.S. an assignment for a committee project was made by E. W. Commery, Committee Chairman 1948-49, to survey "Lighting and Viewing Habits Associated with Television Receivers in the Home."

Results of the survey establish several points which may be given to users by persons selling sets, through newspaper and magazine articles and by directions for use from the manufacturer of sets. Attention to the points so far established can give television users added pleasure and television sellers less service difficulties.

The points which follow offer suggestions applicable wherever sets are in use.

1. Be able to turn the television set to accommodate different numbers of persons for viewing in the room or to allow from viewing from different locations in the room.

2. "You must not have any light in your eyes when viewing the television set" is an often repeated statement but it is not true. Daytime program viewing gives proof of this point.

3. Walls or curtains against which the television set is placed should be plain in color since figured, or too sharp con-

Author: Chairman, Sub-Committee on Lighting and Viewing Habits Associated with Television Receivers in the Home of the Committee on Residence Lighting. Miss Dodds is with the Toledo Edison Co., Toledo, Ohio.

trast in color causes rivalry for attention of viewer. If the wall against which the television set must stand is papered with figured paper or if a plain pale blue green wall, in keeping with the television screen is not wanted use a curtain of sheer material and pull curtain to serve as background when television is in use.

4. Choice of plain material hung in folded arrangement upon the wall as background for a television set gives most pleasant viewing conditions. The folds give a three dimension effect and do away with sharp light pattern back of set when back lighting on set is used.

5. By using fabric shades that are not much brighter than the television tube itself or using opaque shades, lamps may be left on in room. When the lamps used have three light bulbs they should be operated at one of the lower steps. This method reduces the reflections of these shades seen in the safety glass of the television set.

6. Viewing distance from the set should be sufficient to get fusion of horizontal lines across the face of the tube and minor electrical disturbances that may be introduced into the picture from time to time. This fusion is produced at approximately ten times the diameter of the picture tube in inches. This rule applies for the larger and average size tubes since the small size tubes have to be viewed closer than this. Even somewhat greater distances than this basic rule are often desirable.

7. The improved performance of modern television sets in producing brighter pictures and sharper contrasts permit us now to view these pictures in rooms in which lighting is well arranged instead of in the dark. This minimizes glare discomfort sensations or eliminates them.

8. There appears to be a best setting of the brightness and contrast controls for each station. This is usually attained by using a high position of contrast at all times in conjunction with the proper selection of the brightness control. The user should familiarize himself with these controls for each received station when viewing the station test pattern. A best setting of the white and black values, with the intermediate gray steps well spaced between them, in the test pattern, is very useful in finding best picture settings with these controls.

The Value of the Residence Lighting Forum In the Society

Priscilla Presbrey

The purpose of the Residence Lighting Forums, as set forth in the "Suggested Plan for Residence Lighting Forums" adopted by Council in January, 1937, is threefold:

1. To encourage an interest in the Society's work and ideals on the part of those increasing numbers of men and women who are seriously engaged in the residential fields and who should be members of the Society.

2. To promote the application of illuminating engineering principles by a much larger group whose interest, for the present at least, is completely commercial and who offer very limited possibility of membership in the Society.

3. To broaden and strengthen mutually the Society's and the industry's contribution to residence lighting advancement through organized activity.

The three presently active Residence Lighting Forums fulfill these purposes by acting as a bridge between the lighting engineer and the people who are in a position to convey information on lighting to the homemaker: the utility home lighting and home service advisors, the college and high school teachers of home economics, the county home demonstration agents, the interior designers and architects, the designers, manufacturers, and retailers of residential lighting equipment, the department store lamp buyers, sales people, and decorators, the electrical leagues, the eyesight and sight-saving councils, the magazine and newspaper home department editors, radio and advertising personnel, and city planning and housing representatives. To such people as these the Residence Lighting Forum carries the technical developments of the Society, translated into terms which they in turn can carry to the general public. Basic in the Forum's program are the fundamental principles of good functional lighting for the home, the proper selection, and the proper use, of portable lamps, and some of the infinite possibilities of creating beauty in the home by means of light.

The Committee on Residence Lighting Forums believes strongly in the value of this sort of enterprise to the Society, and to the cause of home lighting in general. When the war interrupted home lighting activities, there were six Residence Lighting Forums in the Society. Only one operated continuously throughout the war, and today there are still only three active Forums, affiliated with the New York, Michigan, and Georgia Sections. Plans underway in other centers may lead to the reactivation of one or two Forums, or the organization of new ones. We believe that there are other Sections and Chapters which would find their interest broadened, their work strengthened, and their influence extended, by the organization of a successful Forum.

The present Conference session is planned as a demonstration of what a Forum is and what it does. None of the presentations is intended to be a technical paper on residence lighting. The three chief presentations will be, in summary form, talks such as might constitute the programs for three typical Forum meetings. It is the hope of the Committee that this session will help to clarify the general conception of the function and operation of the Residence Lighting Forum, and to achieve for it recognition as a vital part of the Society's organization.

Author: Commercial Engineering Department, Westinghouse Electric Corporation, Bloomfield, N. J.

Ruth Morris

A Progress Report from The Newest Forum

The Atlanta Residence Lighting Forum didn't spring full grown from anybody's head. On the contrary, the idea of a forum had been mulling around in the minds of a number of Georgia Section members for some time. For years I'd been keeping a scrap book of any information on residence lighting forums published in ILLUMINATING ENGINEERING and the trade magazines.

Atlanta seemed "a natural" for such an organization. It is a population, trade and educational center for the Southeast. The local utility has home economists actively engaged in home lighting improvement. There was reason to believe that a forum would be successful, for the attendance at Georgia Section meetings featuring women speakers was much better than at other meetings. I am not disparaging our men speakers, but am merely trying to show that many visitors were attracted to residential lighting programs. But one such meeting a year certainly was not giving people in the residence lighting field the help and stimulation that the Illuminating Engineering Society could give. The answer seemed to be a Residence Lighting Forum.

With war shortages a thing of the past and home construction again underway; with CLM lamps on the market and more general interest in home lighting than had been evidenced for many years, the time seemed ripe for a residence lighting forum. So the Georgia Section asked that I undertake its formation.

Getting a prospect list was not hard to do. Routine contacts through the years with individuals in related fields gave us the names of manufacturers' agents, fixture dealers, contractors, portable lamp buyers, teachers of homemaking education, some decorators and others who we thought were or might be interested in forum membership. Atlanta architects and the Georgia Section membership were circularized to find interested individuals in these groups. We had a very satisfactory list of prospects for a starter.

Being business people, night meetings would be necessary and dinner meetings very desirable to stimulate attendance. As a special inducement for the first meeting I obtained permission from my company to have the group as our dinner guests in our Assembly Room.

Printed invitations were sent to 71 and we had 42 acceptances for the March 18 meeting. At this time the purpose, plan of operation and other pertinent details of a residence lighting forum were explained by the temporary chairman. Various activities and programs of other forums were cited to indicate some of the potentialities of this type of organization. Membership applications received before and during the meeting totaled 42, so the local organization was assured. Nominating and By-Laws committees were therefore appointed.

The second meeting was a joint meeting with the Georgia Section on April 25 to hear Miss Edith Buchholtz, Home Lighting Consultant, Westinghouse Electric Corporation; 100 people attended. The third meeting was on May 30th with 42 attending. The speaker was Mr. J. H. Murrah, Architectural Lighting Specialist.

We now have 54 members, 30 of whom are affiliates. Besides the utility group, the membership includes 14 lighting equipment manufacturers' agents, 2 electrical jobbers, 5 contractors, 3 teachers, 4 fixture dealers, 1 Electric Membership Corporation home economist and 3 homemakers. The breakdown of the utility group is 13 home economists, 3 commercial lighting specialists, 3 merchandisers, 2 adequate wiring representatives and 1 from the executive department. Several classifications in related fields are not represented in our membership, but we hope to report not only gains in numbers but also in fields represented next year.

The Executive Committee includes, in addition to utility employees, a retail fixture saleswoman, 2 contractors, 1 fixture manufacturer's agent, 1 homemaking-educator and 1 homemaker. There is no lack of enthusiasm over the potentialities of the residence lighting forum in Atlanta, and nothing will be overlooked by the Executive Committee in planning future programs that will keep that interest alive and growing.

Author: Home Lighting Specialist, Georgia Power Co., Atlanta, Ga.

A special organizational meeting was held in Atlanta, Georgia last spring, to establish the Forum's officers, By-Laws and future program. The above group of 44 members and guests participated.

Vision and Illumination

Continued from page 537

server and his experiences as it does upon the external reality which the light presents to the eyes of the observer.

Contrast in a scene, either interior or exterior, depends on subject matter and illumination. The two categories can be separated only at the physical level in terms of the actual light leaving various areas of the scene and in terms of the per cent reflectance of various areas. When the observer is introduced into the problem, a number of other considerations immediately become important.

The variables of concern to the observer are: (1) the spectral reflectance characteristics of each area (*i.e.* in every speech, the colors), (2) the brightness of each area, and (3) the geometrical characteristics of the illumination. In order to present these variables in an orderly relationship the talk is divided into three separate sections. I. Hue and Saturation. Contrast *vs* Brightness Contrast. II. Diffuse *vs* Unidirectional Illumination Effects. III. Reflectance *vs* Brightness Relationships.

Under Section I there will be a discussion and illustration of the appearance of scenes so constructed that they vary primarily in hue, in saturation, in brightness, or in various combinations of these. Under II there will be a discussion of mental transfer of geometrical properties of the illuminant to apparent surface characteristics and texture of objects. Section III considers the problems of contrast due to subject reflectance characteristics as opposed to the brightness relations imposed by the lighting distribution.

The discussion is intended primarily as suggestive and as indicating lines for research and careful thinking. To facilitate this intention, the talk will be illustrated by color photography with about 100 slides.

Troffer Lighted Classroom

Continued from page 535

of an old one. High standards of construction and illumination were set up and it was a problem to achieve the results within the limits of tolerance of glare and brightness that could be expected under high levels of illumination.

As is usually the case, a number of designs were considered, but the final selection of flush troffers, using prismatic lenses was influenced by the desire to make the lighting equipment an architectural part of the construction and also, to take advantage of a unique feature of the troffers, which permit the support of the ceiling by the same means.

An interesting feature of the wiring is that three-phase, four-wire supply permitted wiring adjacent units on different phases, which assists in the final smooth lighting result.

Initial lighting values were from 90 to 125 footcandles in the average room and as little as 80 to 104 in some rooms. Even after depreciation after a year of operation these high levels have been maintained for the most part.

Of perhaps more interest than the lighting level in terms of candles are the facts that brightness ratios were, in almost every instance, within the tolerances set by the American Standard Practice for School Lighting.

Although it is not possible to do so in every instance in the building under discussion it would be highly recommended that all of the crafts concerned in the construction of an interior contribute to the completed livable interior. By this statement we mean that the designer of the floor, desk and other furniture finishes should have a part in the design as well as the decoration of the walls and ceilings. It is felt that could this have been done in every detail that even better results could have been achieved, particularly in the case of the desk top finishes, chalkboard and floor colors.

Preprints in Sets

A limited number of sets of the Conference Papers which were prepared in time for preprinting, are available to I.E.S. Members.

First Come — First Served

$1.50 Per Set

Send remittance with order to

ILLUMINATING ENGINEERING SOCIETY
PUBLICATIONS DEPARTMENT
51 Madison Avenue
New York 10, N. Y.

President's Annual Address

By L. E. TAYLER
President

A VERY interesting and busy year as President of the Illuminating Engineering Society is rapidly drawing to a close. I find this hard to realize, so swiftly have the months passed. With the fiscal year of the Society foreshortened by the valley period of activity following June Council Meeting, I have the feeling of being catapulted into the venerable ranks of Past Presidents. Actually, the administrative year is concentrated into nine months, from October to June. Any contribution that a President may hope to make must be completed in that time.

As reported by the General Secretary, our membership is nearing the 7000 mark. Also, the Society is now represented through 47 Sections and Chapters in Canada and the United States. These figures will continue to grow because the Society is on a sound and healthy basis which nurtures such growth.

As we expand, however, so do the multitude of duties and details of the President, which requires careful consideration, arbitration and decision. I point this out to establish a contention that to execute properly the duties of the office of President, very little time remains for the affairs of a company, business or profession with which a President may be affiliated. In this respect I wish to pay high tribute to our Society's General Office Staff which provides invaluable help and guidance. Without the aid of the Executive Secretary, Technical Director, and Director of Publications, a President-Elect would probably have to plan on divorcing himself entirely from his chosen field of endeavor. It is self-evident that such a situation would entail complications.

I urge Council to consider a "President's Relief Committee." For example, the time has come when the huge task of making committee appointments, for which the President has been totally responsible, must be delegated to an advisory group. A thorough search of talent and capabilities among the membership is required. This would be facilitated by a delegation of this work whereby a proposed list of appointments would be submitted to a President for his approval. A plan of this nature was launched this year and, although still in a formative stage, I believe it has offered some assistance to President-Elect Goddard. This represents only one step in the direction of relief from details and I am certain that coordinated thinking and planning will reveal many others. I feel we should view this situation with due concern as it is possible that some future qualified candidate for the office may of necessity have to refuse the honor because of this time element. It was my good fortune to be affiliated with a company whose management realized the importance of the objectives of the Society and cooperated to the fullest extent in making it possible for me to carry out the duties of President. I wish to publicly express my sincere gratitude to the management of The Detroit Edison Company for making this honor and privilege possible.

In my President-Elect's address in Boston, three points were emphasized:

1. Our financial situation.
2. A combined study of the British Society's plan for a register of Illuminating Engineers.
3. Our professional status.

I want to report briefly on these aims. On each occasion in addressing the delegates to Regional Conferences, the fact that our Society was exposed to inflationary trends was emphasized. A slide graphically depicting income and expense quickly revealed that we are operating on a deficit and the Constitutional allotment to reserve has not been possible. The fact that basic income depends on

Substance of an Address given before the National Technical Conference of the Illuminating Engineering Society, September 20, 1949, at French Lick, Indiana by the President of the Society.

member dues was pointed out. In each case, also, the membership was alerted to a possible increase in dues. To evaluate this problem properly a Task Committee was appointed to study the matter, under the chairmanship of the Treasurer, Professor E. M. Strong. This committee will report early in the next administrative year and you can be assured their recommendations will be based on careful study and broad evaluation.

As to the British plan for register of illuminating engineers, the Project Planning Committee reported many obstacles to a similar plan here and recommended no action be taken. I submitted a second prospectus and an appeal to reconsider as I honestly feel that a concerted effort by the Society to establish qualifications for illuminating engineers will have considerable effect upon recognition of illuminating engineering by State Boards of Examiners for Professional Engineers.

In discussing this situation with members about the Continent, an interesting by-product was uncovered that took the form of questioning the present method of election to full Member grade. I wish to qualify the observation by stating that it was not possible to obtain, this year at least, a sufficiently general attitude to institute immediately committee investigation, but I do feel that a more comprehensive polling of membership would be in order to establish this attitude more firmly. A general summation of viewpoints indicated a need for greater emphasis on qualifications for elevation or election to Member grade. If you will recall, in the plan of the British Society, applicants submitted to examination which also carried identification as Registered Illuminating Engineer (I.E.S.). There was by no means total disapproval of some variation of this idea among those with whom this matter was discussed. For example, an Associate Member after a stipulated minimum time would make application for examination for Member grade. If successfully passed, he would receive his Member certificate. This examination would be prepared by the Society and would encompass bith the academic and practical phases of illumination. If this came about I am sure there would be renewed interest in the work of our Educational Committee, and our Handbook would gain a new value. It is supposed there might also be sufficient value attached to a membership certificate then to have it framed and hung in a prominent place for all to view. I have yet to see an I.E.S. Membership Certificate so exhibited. I regret to say my own is in the bottom of my desk drawer. In one instance, at least, a member of our Society in Texas stated that if he could submit to examination he felt he could qualify for the privilege of full membership, whereas under the existing procedure his situation in the field of lighting did not fall within any of the present categories. I would add also there was some contention that the endorsement of a candidate for full Member grade by those indicated as references could be on a more sincere basis.

The third point, the professional status of the Society, was discussed in every case before Regional Conferences, Section and Chapter meetings and discussions with Section and Chapter officers. I pointed out that our Society may be different from some other professional societies because of necessity our membership encompasses the fields of psychology, health, optics, color, design, research, application, manufacturing and distribution. Also, the end use of our knowledge and techniques is the human being for which you cannot write a mathematical formula. Yet, the underlying foundation of these elements is engineering; sound engineering.

The application of natural and man-made sources of light to effect the illumination of interiors, exteriors, all modes of transportation, photography, the specialized demands of the Armed Services, signal devices, streets and highways and many others, involves the application of light based on engineering principles. This fact is more pronounced today than ever before. User demands are causing us to forge ahead in the more technical concepts of illumination at an ever-accelerated rate. This, I believe, would represent partial proof of the fact that we are a technical and professional organization and as such should be giving consideration to elevating our professional status.

As one factor in this program I have strongly advocated Council approval of the Society's endorsement of the Canons of Ethics for engineers submitted by the Engineer's Council for Professional Development. The objectives of the E.C.P.D., particularly as they apply to the improvement and development of engineering curricula, in addition to emphasizing the need for training within industry, are rather close to the discussions we have had in the Society regarding the possibility of establishing illuminating engineering options in accredited technical schools. I feel certain that a closer affiliation with the "Council" would derive mutual benefits. Their membership is representative of leaders in the educational, industrial and professional fields. The development of the Canons of Ethics is just one tangible example of their interest in raising the level of engineering. The endorsement of the Canons would place us in league with some seventeen other professional societies which

Continued on page 552

Our Society In 1949-50

By CHARLES H. GODDARD
President-Elect

IT HAS BEEN the custom for several years for the incoming president to present his platform to the membership, pointing out the more important accomplishments expected during the next fiscal year. This so-called "Platform Speech" is not mandatory, but it seems to serve a useful purpose in alerting our working membership to some of the objectives of the forthcoming administration.

It must be gratifying to you, as it surely is to me, to realize that within the Illuminating Engineering Society, we have the only group exclusively devoted to illumination. Now, illumination to the layman probably means lighting, but the work of various individuals and technical committees of the Society has pointed up the fact that illumination involves many items and devices which, by nature, are mechanical, psychological, physiological, and which either directly or indirectly affect the economies of our existence. Subsequently, the subject of illumination has taken on all these facets and has, by the same token, imposed upon the administrators of our Society many problems so diverse in nature as to provoke controversy (which sometimes gets pretty hot). Your officers and Council are to be commended on the manner in which they have guided the Society's activities into channels broad enough to allow the maximum of free thinking, and yet have kept its activities within the bounds of those subjects related to illumination.

In this respect, I look upon Council and your national officers as the ones to maintain continuity and coordinatiton. As the same time, the actions of Council must reflect the best interests of our membership. We now have 6,883 members, of which nearly 1,000 are giving freely of their time and talents in the development of the arts and sciences of illumination via some 93 standing committees, general and technical committees, and subcommittees. It is this wholesome, enthusiastic approach to the aims of our Society that I want most to maintain and strengthen during my term of office and this, to me, means bringing to each member a complete realization of what our Society has to offer and how best to make these offerings.

It is my considered judgment that our first interest lies with our individual members. This is followed closely by the inestimable value we give our sustaining members. I think, however, that we often overlook the tremendous impetus we have given and will continue to give the lighting industry as a whole, including, of course, the many allied industries that have learned to admire the work of our Society and to respect our judgment in those mutual matters which extend into their fields.

Committee assignments and the scope of committee activities have been exceptionally well defined within the past few years, but we still must be ready to make any necessary adjustments and modifications in order that the span of operation of these committees will be in tune with the times. In retrospect, it would seem that the lighting industry has really put on seven-league boots in the last ten years. This has placed a heavily increasing responsibility, especially on the technical committees, in keeping our data abreast with the developments of lighting equipment and its application. A good example would be our American Standard Practice for School Lighting. When Jimmy James took on this job, with a splendid committee membership, there was no active school-lighting program afoot in this country. While it took months to complete this school-lighting study, it finally brought together the very latest thinking on modern school lighting and was available in time to aid materially in the proper lighting of schools, which as we all know, has gone ahead at a rapid pace in the United States and Canada. This is a good example in timing, and exemplifies the importance of our position

Substance of an Address before the National Technical Conference of the Illuminating Engineering Society, held September 20-23, 1949, French Lick, Indiana.

in the affairs of man. Just stop for a moment and realize that almost every state and province has a law which makes it mandatory for children to go to school for twelve years. Take one more moment and think about the lighting conditions under which these children have been forced to study, and you will know what I am implying.

I want all committees to assume full responsibility in the disposition of their assignments and have their reports presented according to schedule, with the approval of the entire committee membership, so that Council will not feel called upon to reconstruct any report, but rather be obliged merely to approve or disapprove the report as presented. In my opinion, a proper procedure to follow is to make a committee assignment clear and well defined with the understanding that thorough study and consideration will be given the assignment before a final report is submitted to Council. In this way there will be no need for Council to debate or even discuss at any length the details of a report. Council should anticipate sound, intelligent work by its committees and have confidence in their reported findings.

The Illuminating Engineering Society is set up on a completely democratic basis—from one end to the other. This has pitfalls, however. It becomes easy to let the other fellow carry the load. I am going to ask each one of you to live up to your individual responsibilities. The qualifications and responsibilities of a Council member at times seem never-ending, but basically, this Council member should have an understanding of what the Illuminating Engineering Society represents, a broad knowledge of the lighting industry, a knowledge of lighting sufficient to segregate a real contribution from a rehash of old material, and surely the courage of his convictions.

An official position which has grown in stature is the office of Regional Vice President, and it has been most satisfying to see the large number of Regional V.P.'s who have been able to attend the meetings of Council regularly. The work of these Regional Vice Presidents has strengthened our Society at the local levels and has played an important part in building new Chapters and helping them grow strong. It is my intention to make even more use of these officers during the next year, and I would like to feel that these Vice Presidents will approach the problems of their regions vigorously under the able guidance of Sam Hibben. If your new president can be accused of a bias, it will be my belief that we must continually fight for the prerogative and privileges of Section and Chapter activities — I think of this as maintaining our "states' rights," making sure that there is no domination by a central body.

I would also like to see each Section and Chapter have a study club or technical forum such as have been so very worthwhile in several sections of the country. As mentioned previously, the subject of illumination encompasses so many matters other than the strict science of lighting that we cannot afford to be too restrictive in the talks presented at Section and Chapter meetings. Additional or supplementary meetings, such as are conducted by a Technical Forum, serve a very useful purpose in affording an opportunity to discuss any and all technical matters by those interested members, thereby leaving room on the regular meeting program for those subjects of a more general nature.

Our Regional Vice Presidents must keep on top of another job, which is the work of our extension committees and local representatives. This activity has been of great value to our Society, particularly in doing the spade work which has resulted not only in keeping the torch burning in outlying sections, but also in developing such an interest in lighting that Chapters have seemed to grow where nothing but a seed had been planted a year before. When working with Art Brainerd on the Special Task Committee assigned to study regional boundaries, we made a rather detailed study of the United States and Canada. It seemed to me very logical to expect to have a representative of the Illuminating Engineering Society in every town of 25,000, a chapter in every town of 100,000, and a section in every town of 250,000. This would mean 307 representatives, 51 chapters, and 36 sections and would undoubtedly mean adding several more Regions. Now, I realize this cannot be accomplished in one or two years, but it is surely a goal worthy of attainment.

This extended coverage by our Society should help in solving a few of our financial problems, of which we have more than aplenty at the moment. Our operating budget for next year will run well over $100,000 and the way business conditions are right now, it will be a challenge to maintain our income from individual members, sustaining members, and other sources. Frankly, our financial position has caused considerable concern to your Council and officers and we should all be very thankful for the diligent and intelligent work done by the Finance Committee in keeping our affairs in order. As you all know, the Society is not a profit-making organization and it is only our intention to spend our income wisely in the hopes of giving back to our members and our industry the maximum of benefits, at the same time keeping ourselves financially able to carry on year after year. With this in mind, I do not propose to curtail the services to our membership, but only to effect every possible

Continued on page 552

Annual Address—Tayler

Continued from page 549

have accepted them in the interest of improving technical training.

One of the privileges of this year as President has been to observe broadly the ramifications of the Society's interests and functions. This has resolved in my mind, at least, the contention that we are an engineering society; that we are a professional organization. Therefore, we must be recognized as such, not only in other engineering and professional societies, but also by leaders in business and industry.

We need to develop an educational program similar to that prepared by the Society of Plastics Engineers. Their program has been submitted in booklet form with an editorial preface by M. J. Petretti, their President. With his permission, I will paraphrase this preface by changing the word "plastics" to "illuminating"; it would then read as follows:

> The primary purpose of this brochure is to present an integrated program of professional engineering education in *illumination*, together with a sketch of the types of professional engineers required in this industry and the opportunity thus open to educational institutions in preparing such men for professional careers.
>
> With the hope that this plan may furnish specific guidance to educational institutions interested in establishing engineering courses in *illumination* and be of special interest to industry and to both practicing and potential *illuminating* engineers, the program is presented in considerable detail.

By so paraphrasing, the scope of a valuable and much needed program is practically prepared for us.

We are now at the stage in our Society's existence to give this matter serious consideration so that the Illuminating Engineering Society may become more professional in its characteristics. In presenting these views, I do not mean to imply in any way an aloofness or a separation from realities. Following such a course should not create a tendency to grow away from the field of lighting but the Society should grow more objective and judicial in character. In this way we will gain the respect of the public we serve and thus become far more potent in contributions to each and every commercial enterprise.

Last year in Boston I stated that in the short year ahead, all I hoped to accomplish was the marshalling of some thinking on some of these phases of our Society's growth. I feel satisfied this has been done. In this effort as well as in expediting the multitude of other duties I have experienced the utmost in cooperation. It is the combined efforts of our members, Section and Chapter Officers, Local Representatives, Committee Chairmen, National Officers and our Headquarters staff that forges into a unit, all the elements of accomplishment. To you all, I extend my sincerest gratitude and I assure you being your President has been a privilege and an experience I shall never forget.

Our Society—Goddard

Continued from page 551

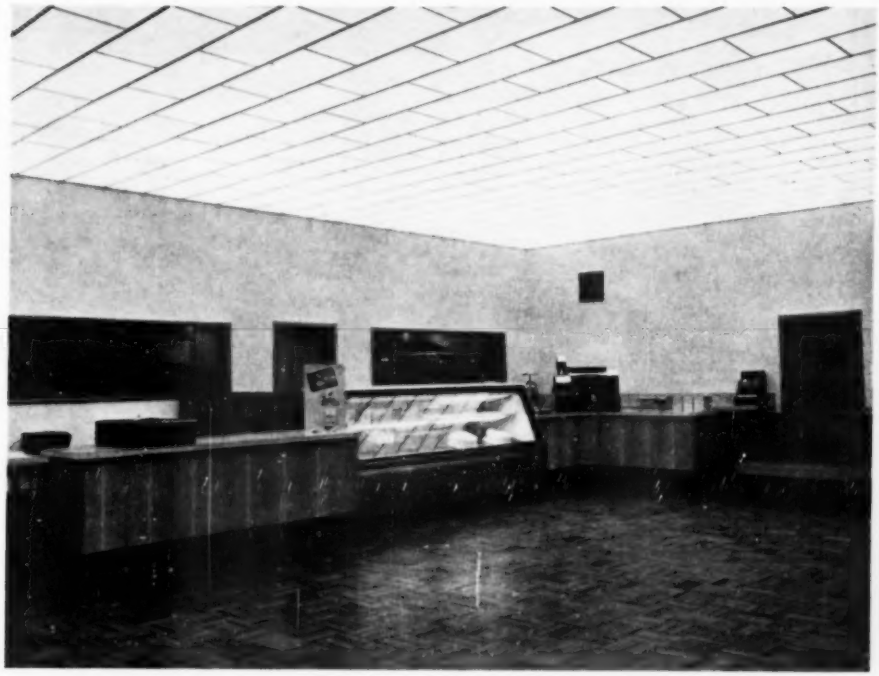
economy to stay out of the red. We surely know how all costs have increased in the past few years, and I sometimes wonder how we have been able to avoid increasing our membership dues. At least we approved the discontinuance of the cash discount on dues payment, and this action undoubtedly will increase our income in a painless manner.

We have tried, at times, to standardize the method of conducting Section and Chapter meetings. Invariably, however, these meetings seem to take on a local flavor — which I find rather agreeable. However, I am going to ask the Junior Vice President, who is in charge of Local Activities, to outline a few basic points which should be followed; such things as recognition of our speakers by means of newspaper and other publicity releases, the matter of public relations in general as they may be handled locally, to name a few. I guess what I'm really trying to say is that we should line up those fundamentals which have been tried and proved beneficial to the running of any organization such as ours. Do not think this is a plan for legislating local affairs, as I am not in favor of this. But since we do change officers practically every year, there is bound to be a difference in the attitudes and leanings of each new officer, and what I want to accomplish here is a continuity of policies, procedures, and practices from one year to the next. This is what we attempt to accomplish at the national officers level and it has proved most worthwhile.

Considering the unsettled and turbulent months we have been going through this year in the business world, one could easily consider the future months of our Society as most unpredictable. The situation reminds me of the old mountaineer who came down from the hills and who, while gazing at a road sign said, "I can read how fer, but not whar to." Fortunately, this is not necessarily true of our Society, since we have experienced many unusual circumstances over the last 43 years. As I look ahead to the coming year, I am completely confident that regardless of what problems confront us, we will cope with them in the same vigorous, cooperative manner which is so typical in our Society.

Lighting for a Food Shop

LIGHTING OBJECTIVE: To illuminate the small retail corner of a new building for the manufacture of wrapped sandwiches and party foods to impress passers-by with the company's name, product, and clean modern kitchens.



Installation at Duchess, Inc., 2350 Grove Street, Oakland, California; lighting designed by Spott Electrical Company and Donald R. Keebaugh, Oakland, California

General Information: This store is one corner of a new building for the manufacture of wrapped sandwiches, box lunches, and party foods. (The major part of the business is wholesale, handled by telephone or through delivery drivers.) The room is 30 feet deep, 50 feet wide, and 11 feet high from the floor to the bottom of the luminous glass ceiling. The true ceiling, 10 inches above the glass, is painted a flat white. The chartreuse walls have a reflectance of 65 per cent, and both the natural wood floor and the blond store furniture have 20 per cent reflectances.

Installation: Translucent glass panels (18" x 36") are suspended below continuous, ceiling mounted cold cathode tubing on 18-inch centers. The following equipment was used:

Sylvania 20 mm, 3500K cold cathode tubing
Acme 60 ma, high power factor transformers
Corning Alba-Lite glass, form 66

(over)

A.I.A. File No. 31/11

After approximately 200 hours of operation the installation provided an average of 63 footcandles with an input of 4.2 watts per square foot. The average brightnesses were:

Luminous ceiling	
30° above horizontal line of sight	115 footlamberts
90° above horizontal line of sight	125 footlamberts
Wall	35 footlamberts

The only additional lighting needed were one display case equipped with two 30-watt fluorescent lamps, and an outdoor sign outlined in luminous tubing.

Lighting data submitted by Donald R. Keebaugh, Commercial Lighting Representative, Pacific Gas and Electric Co., Oakland, California as an outstanding example of store lighting tailored to the customer's exact needs and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 51 Madison Avenue, New York 10, N. Y.

Series XIV 9-49

A Photoelectric Brightness Meter

By YORICK G. HURD

The new meter described in this paper was designed and constructed for a thesis, accepted as partial requirement for the degree of Master of Science at Tufts College in 1947.

IN THIS PAPER, non-standard proposed international terminology[1,2] has been used. These are as follows:

Pharos — F, the total luminous output of a light source (lumen). Sometimes called luminous flux. Example: The pharos from a certain 200-watt incandescent lamp was found to be 3650 lumens.

Pharosage — D, pharos incident on a surface divided by the area of the surface. Example: Incident pharosage (lumen per square meter) equals "illumination." For the above lamp at a distance of one meter 3650/4 or 180 lumens/m^2 would be produced on a surface that is perpendicular to the light rays. A value of "illumination" recommended by many illuminating engineers for offices is 50 footcandles, which is equal to 538 lumen/m^2.

Helios — H, is a term that specifies the brightness of a surface or of a light source as viewed from a particular point. For instance, sunlit water does not have a uniform "brightness" but the helios depends on the angle of observation. The helios of the water also depends on the atmospheric conditions between the observer and the water. Brightness (helios) depends on the position of the observer, the direction of his line of sight. Helios is what you see when you look about you.

The precise definition of helios is contained in the equation:

$$H = \pi \lim_{\omega \to 0} \frac{D}{\omega}$$

Where H = helios (blondel)
ω = solid angle (steradian)
D = pharosage received through solid angle ω (lumen/m^2).

To visualize the above formula, imagine a long opaque cylinder of zero reflectance, with a photocell placed at one end. The photocell measures the incident pharosage D received through the end of the long cylinder. If the opening at the end of the cylinder is reduced until the region of the field of view subtended is of uniform helios, then the helios is:

$$H = \pi \frac{D}{\omega}$$

The paper describes a portable instrument for the measurement of brightness (helios). The meter differs from previous meters in the size of its field of view. The conventional photographic exposure meter is a brightness meter which accepts light through an angle of about 30° from the axis. The readings of such instruments therefore give merely an average brightness (helios) over the entire field.

In many cases, however, it is necessary to measure the brightness (helios) of a small region. A previous instrument[3] used fields extending from 5° to 50° from the axis normal to the light sensitive surface. The new instrument, described in this paper, is different in that its visual angle is 1°. The angle used approximates the visual angle subtended by the fovea of the human eye. By use of improved electronic equipment, it is possible to obtain good results with such a small angle and to measure values of brightness (helios) as low as 50 blondels. The upper limit depends upon the size of the opening in the shields and the circuit parameters. The remainder of the paper is a description of the design and construction of the meter, and part is devoted to a discussion of the method of using the meter, its calibration and limitations.

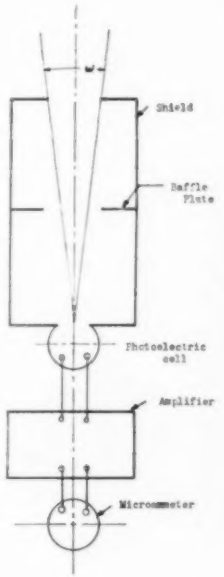
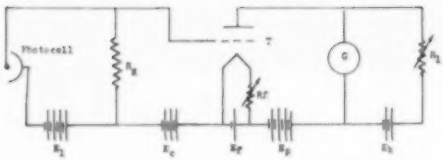


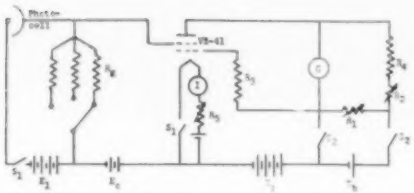
Figure 1. Schematic diagram of a photoelectric helios meter.

MR. HURD is a research physicist at 20th Century Fox Inc., New York, N. Y.



R_g	Grid leak resistor	E_c	Photocell voltage
T	Electrometer tube	E_g	Grid bias voltage
G	Microammeter	E_f	Filament voltage
R_c	Plate resistance	E_p	Plate voltage
R_f	Filament resistance	E_b	Bucking voltage

Figure 2. Direct-current amplifier for photocurrents.



R_g	10^{9}-10^{10} ohms	E_b	1.5 volts	R_5	25 ohms
E_1	30 volts	R_4	7500 ohms	I	10 ma.
E_c	3 volts	R_3	900 ohms	G	microammeter
E_p	6 volts	R_2	10^{4} ohms	S_1	two S.P.S.T. switches
E_f	1.5 volts	R_1	3000 ohms	S_2	one S.P.S.T. switches

Figure 3. Circuit used for helios meter.

Design

The instrument was built around an RCA 925 caesium-oxide photo-cell. An amplifier is used to multiply the output of the cell. A current output, which is directly proportional to the brightness (helios), is read by means of a microammeter or galvanometer. A schematic diagram of this design is shown in Fig. 1. A basic circuit diagram of the instrument is shown in Fig. 2.

The principle of operation is as follows: when light falls on the cathode of the photo-cell, electrons are emitted because of the photo-electric effect. These electrons are attracted to the anode and the current produces a voltage drop across the grid leak resistor. The current is very small, but since the resistor is large (of the order of 10,000 megohms), the bias voltage will be changed appreciably. The plate current will be indicated on the galvanometer "G" (Fig. 2).

The shields were constructed to give approximately the solid angle subtended by the fovea of the human eye. It was necessary to prevent light from entering the photoelectric cell from outside of this solid angle. To do this, several baffles are inserted as indicated in Fig. 1. To check the efficiency of the baffles, one looks through the shield from the end that is to be placed next to the photo-cell. No light should then come to the eye from the walls of the shield. Another type of shield could be constructed to enable the instrument to measure adaptation helios.[4]

Construction

After experimenting with several other circuits the following circuit was decided upon, Fig. 3. This circuit uses a Victoreen tube, the VX-41 which is a very small electrometer tube requiring an ordinary No. 2 flashlight cell to heat the filament. One cell can operate the filament for eight hours a day for a month. The plate voltage required is only 6 volts and this can be supplied with a bias cell of $7\frac{1}{2}$ volts. The extra $1\frac{1}{2}$ volts is used to apply the bucking voltage necessary for adjusting the microammeter to zero. Small Mallory grid bias cells are used to bias the VX-41. The grid-leak resistor, grid-leak resistor switch, bias cells, VX-41, and the photo-cell are all mounted in a light-tight metal enclosure. (See Figs. 4 and 5.) This design saved considerable space and weight over previous de-

Figure 4. A portable helios meter.

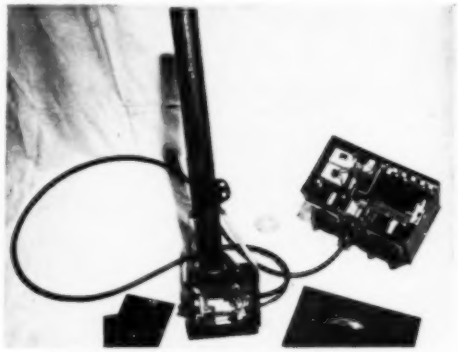


Figure 5. Construction of the helios meter.

signs. The complete meter with batteries weighed $10\frac{1}{2}$ pounds, and was as sensitive as an earlier instrument which weighed 36 pounds with batteries. The weight could be further reduced by using aluminum instead of steel cabinets.

During construction it was noticed that nearly all parts had to be shielded electrically. The photo-cell must be shielded electrically and optically. When the instrument was first built a very small hole in the corner of the metal box caused trouble due to leakage of light. After the hole was covered, the plate current was still erratic when the metal cover of the box was touched. The cover was found to be insulated from the rest of the box by the black paint covering the entire box. After the cover was grounded, the circuit became stable in operation.

Switches were installed so that the filament current could be turned on before the plate voltage was applied, as recommended by the Victoreen Company.[5] If greater sensitivity is desired, it can be obtained by using an external galvanometer. A telephone jack is included on the panel so that such an external meter can be employed.

Calibration

The method used for calibration was as follows. All light was shut off from the photo-cell, and the microammeter was set to zero by varying R_1 for coarse adjustment and R_2 for fine adjustment. The cover on the shield was then removed and the reading on the microammeter recorded. A standard lamp, calibrated at the Electrical Testing Laboratories, provided a known pharosage on a diffusing white surface of known reflectance. The brightness (helios) meter is pointed at the surface of known brightness and the microammeter is read. The pharosage on the surface is then changed by altering the distance from the surface to the lamp and the procedure repeated. The brightness (helios) of this surface is therefore:

$$H = \rho D$$

Where: H = Helios (blondels), reflectance of standard surface,

D = pharosage incident on surface (lumens/m²).

These readings were arranged in tabular form. The microammeter readings were then plotted against helios, Fig. 6. These plots are for all practical purposes linear. It can then be said that the microammeter readings are proportional to the light falling on the photo-cell. Curves can be drawn for various openings and different values of the grid-leak resistor.

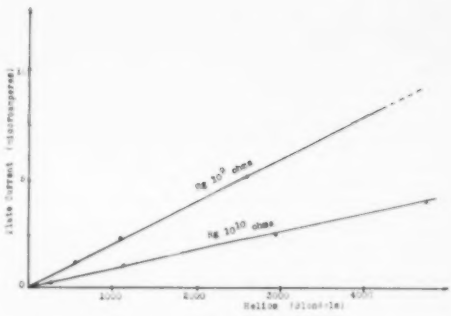


Figure 6. Calibration curves.

Conclusions

The meter described in this paper eliminates many of the disadvantages of other types of brightness meters because it is portable; it gives readings directly without subjective judgments, and it can measure a large range of brightness values even though they be of small area. The instrument can be made to have the same spectral sensitivity as the human eye by the use of filters. There are commercially available compensating filters for photo-cells which can be used with the instrument.[6] Another stage of amplification might be used to increase the sensitivity of the instrument if needed when a filter is used. The RCA-926 and the IP25 are two phototubes which when used with proper filters, simulate the response curve of the human eye.[7] Or, by the use of multiplying factors, the instrument can be standardized for each type of light. Since a meter of this type measures the helios of a small area, the new instrument may be of value to photographers, to movie technicians, television experts, and should be of value to illuminating engineers in investigation of room lighting. The meter can also be used by illuminating engineers in demonstrating and testing lighting installations and lighting equipment where its accuracy, portability, and simplicity will be of value.

I wish to acknowledge the assistance of all those who contributed their time and knowledge to the making of this instrument and particularly to Professor Domina Eberle Spencer.

References

1. Moon, P., Spencer, D. E., "Brightness and Helios," ILLUMINATING ENGINEERING, Vol. XXXIX, 1944, p. 513-516.

2. Moon, P., Spencer, D. E., "Internationality in the Names of Scientific Concepts, Comparison of Photometric Systems," *American Journal of Physics*, 15, 1947, p. 84-92.

3. Hurd, Y. G., "Measurement of Helios with a Barrier-Layer Cell," ILLUMINATING ENGINEERING, Vol. XLI, 1946, p. 306-311.

4. Moon, P., Spencer, D. E., "Simple Criterion for Quality Lighting," ILLUMINATING ENGINEERING, Vol. XLII, 1947, p. 325-364.

5. *VX 41 Electrometer Tube*, Victoreen Instrument Co.

6. *Wratten Light Filters*, Eastman Kodak Co., 1945.

7. *RCA Tube Handbook*, Vol. III, 1947.

Carlisle Room at NYU Demonstrates Lighting for Doctors

THE IMPORTANCE of lighting education to medical doctors specializing in the care and treatment of the human eye has been given special recognition by New York University College of Medicine. At its Bellevue Medical Center in the City of New York it has established a room especially equipped for the practical working demonstration of the techniques of modern lighting and the effects of different levels of illumination. The Carlisle Room in one of the older class and laboratory buildings serves as a reference library and as a conference and study room extensively used by physicians studying to become specialists in ophthalmology. Prior to its relighting and environmental reconditioning, the Carlisle Room was a traditionally dim and shadowy area where seeing was accomplished principally by will-power.

The project involved the installation of luminous indirect fluorescent lighting fixtures; color-conditioning of the walls, ceiling, and woodwork; and the application of light-colored linoleum working surfaces on desk and table. The results obtained

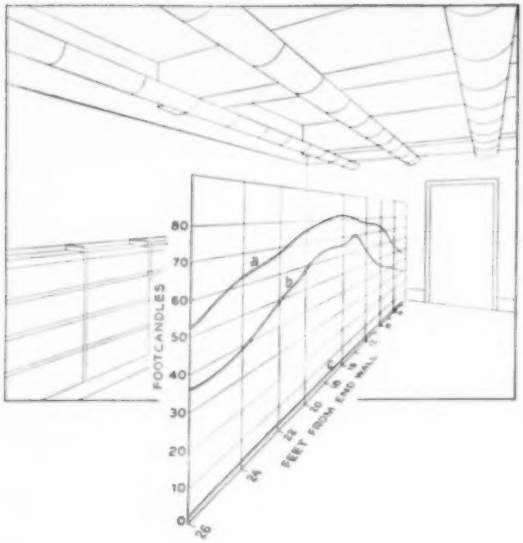
BEFORE redecorating and relighting, the 15x30x12-foot room was illuminated by two indirect spun anodized aluminum luminaires containing 500-watt filament lamps. (photographic exposure — 3 minutes.)

AFTER redecorating—illuminated by nine plastic luminous indirect luminaires each containing four 3500K 96" T8 slimline lamps operating at 200 ma. (photographic exposure—1.5 minutes; same camera aperture as "before" photo.)

and the contrast between the old and the new are graphically illustrated in the accompanying illustrations, especially the color reproduction which was made available to ILLUMINATING ENGINEERING through the cooperation of the E. I. du Pont de Nemours & Company. The color view gives a first-hand insight into the important part played by color in coordination with light in the provision of a pleasant and effective working environment.

Because the Carlisle Room is used not only for research and study purposes, but also as a practical demonstration laboratory in direct connection with the University's special course in Occupational Aspects of Ophthalmology, the original indirect incandescent fixtures were left in place and the new fluorescent installation was made in three units. Thus, there are four groups of lights, each susceptible of individual control. The filament lamps give about three footcandles at the working plane and the three fluorescent groups give 20, 40 and 60 footcandles respectively with one, two or three rows on. These are "in service" readings under normal operating conditions. It is of particular importance that this installation is in a room of the ophthalmological library that is regularly used by the students. This enables the students to work for substantial periods of time under the different levels of lighting. To a large extent this takes care of the problem of adaptation to differing levels of illumination, and also enables the students to judge the ease of performance of different visual tasks under different levels of illumination. This is an infinitely more effective instructional method than is the next best choice: the use of lantern slides or the brief inspection of some commercial or industrial installation. It has been found that the 20-footcandle level is very satisfactory for casual reading and for conferences; that the 40-footcandle level best facilitates accurate reading at the rate of ordinary study; and that the 60-footcandle level is very useful for sustained,

The Carlisle Room is an example of the coordination of illumination, brightness and color conditioning. The ceiling is white (85% RF); walls light green (53% RF); bookcases, doors, baseboard and other trim medium green (26% RF); desk sides and desk chairs grey (26% RF); desk and table tops grey linoleum (35% RF).



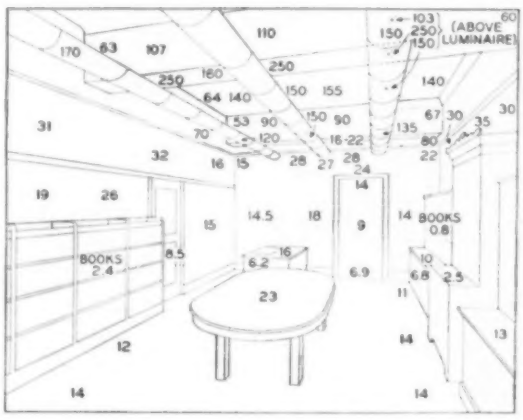
Footcandle distribution along centerline of room 30 inches above floor:
a. After redecorating, all fluorescent units on
b. Before redecorating, all fluorescent units on
c. Before redecorating, original filament lamps on.

concentrated reading of detailed matter.

The Carlisle Room project was a cooperative venture planned and coordinated by Charles P. Tolman, consulting engineer, director of the industrial program for the National Society for the Prevention of Blindness. The I.E.S. contributed the services of Technical Director C. L. Crouch and his assistant, Eve Freyer, in the preparation of technical material and the coordination of engineering performance data. The Lighting Department of Consolidated Edison Co. of New York made illumination measurements. All equipment and materials used were contributed by the manufacturers: Paints for color conditioning and glare elimination, by E. I. du Pont de Nemours & Company; special non-glare linoleum for table and desk tops, by Armstrong Cork Company, Inc.; semi-indirect fluorescent lighting fixtures, by F. W. Wakefield Brass Company.

The installation was contributed for use in the course in Occupational Aspects of Ophthalmology, first given by the New York University College of Medicine in 1947. This course is an outgrowth of the industrial sight conservation program of the National Society for the Prevention of Blindness. Although several medical schools have introduced lectures on some phases of the subject, NYU College of Medicine was the first to present an organized course as an integral part of postgraduate ophthalmology.

It is highly important that the ophthalmologist serving industry be well informed on the subject of illumination because of its direct relationship to personnel welfare and efficiency. Not that the doctor should be an illumination expert, but he should know at least the rudiments — that effective illumination for a job is not obtained by luminaires alone but necessarily includes the proper conditioning of wall and other reflecting surfaces to eliminate glare and improve visual performance; that the need for such treatment increases with the higher levels of illumination needed for accurate seeing on production work; and that eye comfort can be maintained at high lighting levels if the other factors are properly controlled.



Room brightnesses (footlamberts) after reconditioning, all units on. Significant brightness ratios: task (text on table)/table top 2:1; task/books 18:1; task/door 5:1; task/floor 4:1; task/ceiling 1:4; luminaire/bottom of beam 1:1.7.

Is Lighting Saturation in Sight?

By SAMUEL G. HIBBEN

Editor's Note: **In the planning and development required for the life and full public-service potential of an industry such as the lighting industry, it obviously is desirable upon occasion to pause and take stock, to examine critically, to re-evaluate without inhibition. Picking up the theme of a little known study made two decades ago, Mr. Hibben has substituted 1949 figures and observations for those of 1929 — and suggested some conclusions. The author calls attention to the fact that this is not a report of any committee of I.E.S. — it represents only one of several possible analyses presented to stimulate additional study. Concise discussions of Mr. Hibben's article are invited and, to the extent possible, will be published as Letters to the Editor in the "It Seems to Me" columns of ILLUMINATING ENGINEERING.**

IN MAN'S relation to his world and to the universe, the greatest single fact in his life is vision. This physical vision inevitably requires light, either natural or man-made. Practically all of his waking hours — fully two-thirds of man's lifetime — is spent under some kind of light, and probably close to one-third of his vision is dependent upon artificial light.

At the end of nearly a half century of dissemination of knowledge upon the part of the Illuminating Engineering Society, it may be appropriate to appraise the progress that has been made in the facilities for vision and to estimate the parameters of lighting, both as to the completeness of the task done today, as well as an estimate of the horizons of tomorrow. One question which will not soon be answered, but which may intrigue many scientists, is "just where is the limit of artificial lighting and is saturation imminent?" This discussion attempts to present some evaluation of today's status of lighting in relation to tomorrow's possibilities.

Some indices of lighting growth can be taken from the following records: In the United States in 1939 there were used approximately 519 million general service incandescent lamp bulbs. This figure grew to 845 million in 1948. If lighting has grown at the same rate as lamp bulb usage, then the increase has averaged about 8 per cent each year. (See Fig. 1)

Since the introduction of the fluorescent lamp in 1938, the United States annual consumption has grown to exceed 80 million units. (See Fig. 2) When appraising the growth of the generation and usage of light, this latter figure is doubly important because the average incandescent filament lamp sold today (80 watts at 16 lumens per watt) generates about 1280 lumens, whereas the average fluorescent lamp generates approximately twice as many lumens.

Considering all of the incandescent and fluorescent lamp shipments taken together in this country, it is interesting to note that at this time the annual consumption is on the order of 925 million units — or 6.25 large lamps per capita. Since 1916 and in the 22 years up until 1938, the increase in the use of incandescent lamps in the U. S. amounted to approximately 362 million. (See Fig. 1) A most noteworthy fact is that in the decade since 1938, the *increased* use has been greater—in other words, it is fair to assume that lighting has improved at least in quantity as much in the past ten years as in the preceding twenty. To add emphasis to this assumption, it might be noted that about 10 years ago the average size of incandescent lamp used was 60 watts, whereas the average lamp size today is approximately 80 watts. Add the increased efficiencies to the increased wattages and one cannot doubt but that the dissemination of lighting knowledge and the expansion of lighting practice has led to the generation and usage of a great deal more light!

During this immediate year (1949) there may be little or no consequential increase in the numbers of either incandescent or fluorescent lamps consumed, but there is good reason to expect that eventually both curves will gradually move upward even though at a more conservative rate of growth. Even so, more and more lumens will be generated by the light sources that are used, and more and more satisfactory vision will result because of the better lighting tools.

Another indication of the expanding horizons of

MR. HIBBEN is Director of Applied Lighting for the Westinghouse Electric Corp., Bloomfield, N. J.

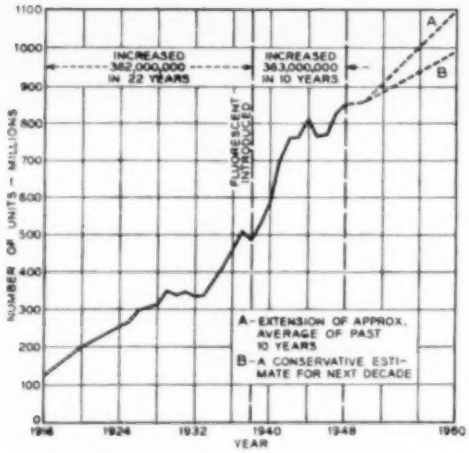


Figure 1. Incandescent lamp shipments.

lighting can be had by reference to the estimates of the amount of electric energy used for the generation of light. Fig. 3 records the fact that today it is estimated that more than 80 billion kilowatt-hours are used annually for lighting. Since it is estimated that the total generated electric power in this country in 1949 will approximate 247 billion 900 million kilowatt-hours, and taking the estimate for 1949 to be approximately 82 billion kilowatt-hours for lighting alone, we see that roughly one-third of our generated electricity is used for the production of lumens.

In the recent past, the growth of lighting power has been phenomenal! Just what the immediate future promises is uncertain, but three estimates have been made, marked by the dotted curves of Fig. 3 as *A*, *B*, and *C*. The growth of the kilowatt-hours devoted to the production of lumens might logically be that of curve *B* or it may be more reasonable to take a conservative view and estimate that the growth of lighting power would approximate curve C. In any case, there will be assurances that more lamps and more kilowatt-hours will be available; that light sources will continue to generate more lumens, and that a more intelligent use of these lumens will lead to more comfortable and more complete vision.

As phenomenal as it seems, the fact that today's usage of lighting power in kilowatt-hours is some two and one-half times the usage in 1938 does not fully depict the recent upsurge of lighting. Considering the data available from lamp shipments — efficiencies, lamp life, etc. — it seems that this country is actually now using almost four times the total lumen-hours compared to the usage in 1938! Today's estimate is 1700×10^{12}; ten years ago, 415×10^{12} lumen-hours annually.

Where is lighting saturation? Are we close to the fulfillment of all of our lighting needs? Is vision satisfied?

Twenty years ago there was published a very interesting analysis of the use of artificial light, leading to an estimate of the relations between the lighting at that time and the probable amounts of light that might represent a reasonable goal. The committee* making this first survey came to the conclusion that upon the basis of *minimum good practice* at that time (1929) the "lighting saturation" figure was of the order of 30 per cent. On the basis of *minimum recommended levels*, the saturation was 17 per cent. On the *probable level of greatest economic advantage*, the saturation figure was said to be 13 per cent; and on the *probable levels for eye consideration* only, the figure was 3 per cent. In other words, 20 years ago there was some evidence that the art and science of artificial lighting were rarely put into practice to an extent of achieving more than some 20 per cent of what was then judged to be reasonably good standards.

What might be the situation today? Following the same course of analysis, but changing some of the figures of this first saturation survey where

*Messrs. E. E. Free, R. B. Grove, Ralph Neumuller, E. E. Darting, S. G. Hibben. Credit is due this committee for its new approach to a difficult problem. The original report was presented before the A.I.E.E. by the Lamp Committee of the National Electric Light Association.

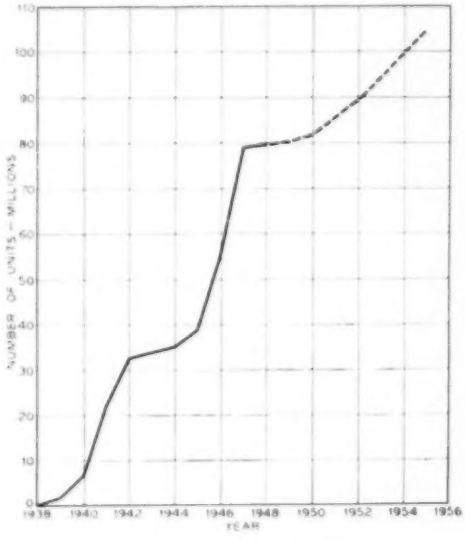


Figure 2. Fluorescent lamp shipments.

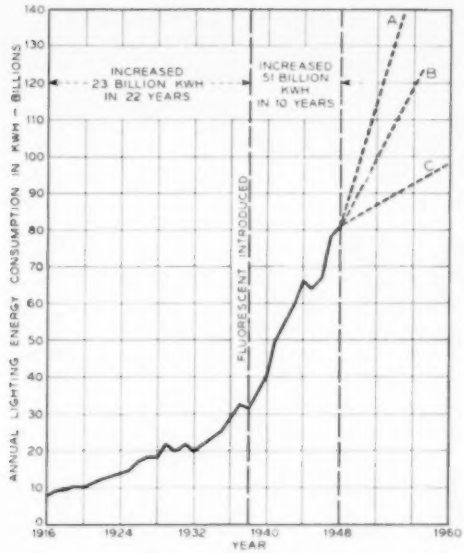


Figure 3. Growth in electric power consumption for lighting. A—Prolongation of 1947-1948 trend. B—A more probable trend assuming a period of general prosperity. C—A conservative expectancy of average growth.

such changes seem justified in light of present-day knowledge or of present-day populations, it is of interest to see what conclusions might be reached.

First, one might accept the figures of Table I as the beginning of a rough approximation of today's conditions. Here there will undoubtedly be differences of opinion, but the footcandle figures given in Table I are chosen from an average opinion of many authorities and have been critically selected. It may be noted that today's minimum recommended levels are not necessarily the optimum ones for good vision, and that levels of economic advantage will change as costs and benefits change.

In choosing three major classes of seeing, "work" is typified by such functions as reading, sewing, office or clerical tasks, skilled factory work. The seeing tasks needing "social" illumination are such as dressing, eating, unskilled games, or operations in public assemblies. By "utility" illumination is meant that for storage yards, hallways and warehouses, city streets, and for relatively simple seeing tasks, such as home conversation, audition of radio programs, or largely for decoration.

From the census records there are about 40,700,000 households in the United States, so for the purposes of this approximation, we can take 3.6 people per household. The average American family then could be classified as in Table II. Guided somewhat by the former surveys, we may take the next step and consider Table III as representing the light-hour needs of an average family. Here again the data cannot be exact, but the approximations seem fair and on the conservative side.

TABLE I.—Footcandle Levels for Quantitative Lighting Approximations

	Work	Social	Utility
Minimum "fair practice" at present	15	5	3
Minimum recommended levels (codes)	30	15	5
Probable levels of economic advantage	50	30	10
Possible levels desired from eye-considerations only	300	50	30

TABLE II.—Classes of Persons in Average Family

	Per Cent	No. Persons
Infants (under 5 years)	10.9	0.393
Children (5-14 years)	20.9	0.752
Working adults	40.0	1.440
Housewives	28.2	1.015
	100.0	3.60

TABLE III.—Light-Hour Needs of Members of Average Family

	Daily Person-Hours		
	Work	Social	Utility
Infants			
Bedroom, etc.	.....	1.00	.....
Totals	0.00	1.00	0.00
School Children			
Housework and reading	2.00	.....	.....
Meals and social	.....	2.50	1.0
In school	2.00	0.50	1.0
Totals	4.00	3.00	2.0
Working Adults			
Dressing, toilette	.....	0.75	.....
Work, at office, etc.	5.00	2.00	2.00
Home reading	1.00	.....	.....
Meals, social	.....	2.00	3.00
Totals	6.00	4.75	5.00
Housewives			
Dressing, toilette	.....	1.00	.....
Work, sewing, etc.	3.00	2.00	3.00
Meals, social	.....	2.00	3.00
Home reading	1.00	.....	.....
Totals	4.00	5.00	6.00

Multiplying the number of persons of an average family by their individual light-hour needs, we arrive at Table IV. In this appraisal we consider the usage of man-made light only, and an effort is made to average the seasonal or geographical or social standards of the entire country.

TABLE IV.—Total Light-Hour Needs of Average Family

	Persons in Family	Total Daily Person-Hours		
		Work	Social	Utility
Infants	0.393	.....	0.39	.....
School Children	0.752	3.00	2.25	15.0
Working Adults	1.440	8.64	6.83	7.20
Housewives	1.015	4.06	5.08	6.09
	3.60	15.70	14.55	14.79

Table V is easily obtained from the preceding data, and results in an estimate of the average artificial light-hours for the present (electrified)

TABLE V.—Artificial Light-Hours for the United States

	Work	Social	Utility
Daily Person-Hours per Family	15.7	14.6	14.8
Daily Hours for 36,000,000 Families, Millions (000,000 omitted)	565	525	533
Total Annual Hours, Millions (000,000 omitted)	206,200	191,500	194,700

population in the United States. The thirty-six million families represent those reached by or having electric service for lighting. Where, in this country, the use of electric power for lighting does not exist, it is not likely that the needs of artificial light are paramount, and these cases are omitted from this survey.

Now we come to an assumption which is subject to wide deviations of opinion, but, in the light of the ultimate findings of this method of appraisal, these calculations do not seem unreasonable. They assume that for work purposes the average individual directly uses illumination over about 100 square feet of area, and about 200 generated lumens per usable footcandle. Observations of factory workers at machines or benches, or of retail clerks, bookkeepers, school children and housewives tend to confirm these rough assumptions. It is considered that half the generated lumens are specifically useful for the seeing task. For social lighting we estimate 200 square feet per individual and 400 generated lumens per footcandle, and for utility lighting, 400 square feet per individual and 800 generated lumens per footcandle.

Today the average efficiency of the average illuminant is of the order of 16 generated lumens per watt. Using this figure, average work illumination would require about 12.5 watts per footcandle; social illumination, about 25 watts per footcandle, and utility illumination, about 50 watts per footcandle. These figures are per-person.

The final step in this appraisal is to use the footcandle values of Table I together with the estimated watts per footcandle mentioned above, multiplied by the hours of use (Table V) and the results in each classification of lighting will be an estimate of the total kilowatt-hours required for the generation of the necessary artificial light. Thus Table

TABLE VI.—Lighting Needs Expressed in Electric Energy
In Millions of Kilowatt-Hours (000,000 omitted)

	Work	Social	Utility	Total
Minimum "fair practice," now	38,600	24,000	29,200	91,800
Minimum recommended levels..	77,200	72,000	48,600	197,800
Probable levels of economic advantage	129,000	95,600	97,200	321,800
Possible desirable for eye considerations*	774,000	240,000	291,600	1,305,600

*For 300 ft-c levels undoubtedly illuminants would normally have efficiencies higher than 16 lumens per watt.

TABLE VII.—Approximate Percentage Saturation in Artificial Lighting
Based on 1949 Estimated Lighting KWH of 83 Billion

Class of Lighting	Needed KWH, Millions	Saturation
Today's Fair Practice	91,800	90%
Minimum Recommended Levels	197,800	42%
Levels of Economic Advantage	321,800	26%
Desirable for Eye Considerations	1,305,600	6.4%

VI expresses an approximation of today's lighting in terms of electric power.

Many objections can be raised to these approximations, and they obviously represent only one method of appraisal. However, in justification of their presentation, one may note that the estimated kilowatt-hours for "minimum fair practice" illumination today agrees reasonably well with the total kilowatt-hours used for lighting depicted by Fig. 3.

In the four classes of illumination, the final Table VII suggests that perhaps on the basis of today's "recommended" but not necessarily best levels — such as 30 footcandles for average schoolrooms, 20 footcandles for some classes of manufacturing, etc. — lighting practice is of the order of 40 per cent saturated. On the basis of probable levels of economic advantage (at today's costs) this analysis indicates a saturation figure of about 25 per cent. If we consider the illumination best chosen for eye considerations, then it might seem that the present-day saturation is of the order of 6 per cent.

In the considered opinion of other industry groups, it has been stated that homes and factories need four times the amount of good light that they are using today. If the above appraisals are approximately indicative, then to attain to levels of economic advantage, we do indeed need four times more light!

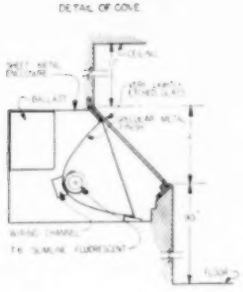
About twenty-five years ago it was noted that for some ten years the footcandle levels had risen (roughly doubled), but that the electric power for lighting had held almost level. The watts-per-square-foot changed very little. Lighting advances had rested upon light-source efficiency advances. This has not continued to be the case entirely, for today we find more liberal wattages, better illuminants, and longer burning hours, all adding to the advance of better lighting.

Whatever methods of study are employed — and recognizing that the needs of better lighting may grow as our seeing tasks become more exacting or more complicated, or as we seek for greater visual comfort and better visual hygiene — we may conclude that lighting saturation is yet far distant.

Cove Lighting for a Living Room

LIGHTING OBJECTIVE: To provide uniform, glare-free general cove lighting for a residential interior.

Installation at Horizon House, Lighting Institute, General Electric Co., Nela Park, Cleveland, Ohio



General Information: The room is approximately 23′ x 17′ x 8¾′. Reflectances and predominant colors are indicated below:

	Reflectance	*Color*
Ceiling	80%	White (Acoustone)
Walls	55	Pale grayed yellow-red
Carpet	30–40	Sage
Tops of desk, fireplace, cabinets	45	Horizon blue
Furniture	20–60	Blue, flamingo red, citron
Natural wood		Burled maple

(over)

A.I.A. File No. 31/12

Installation: The room is designed for several alternate methods of illumination. The cove, which is 21'4" long, employs eight 64-inch slimline fluorescent lamps, four on each side of the room. Focal length of the parabolic reflector is $\frac{5}{8}$". The bottom edge of the cove is 7'6" above the floor. This provides a total of 17,200 lumens, and together with the four ballasts required (G.E. #5965577) consume 408 watts. The average horizontal illumination across the center of the room on a horizontal plane 30 inches above the floor is 11 footcandles (maximum—12.4, minimum—10.8). The brightnesses measure:

Middle of Ceiling		
Center	3.5	footlamberts
2 feet from center	3.9	"
4 feet from center	6.1	"
6 feet from center	16.0	"
8 feet from center	40.0	"
Wall (above cove)		
6 inches below ceiling	16.2	"
$10\frac{1}{2}$ inches below ceiling	19.0	"
Glass Cover on Cove (viewed across room)		
Eye level standing (66")	108	"
Eye level seated (41")	68	"
Wall (below cove)		
14 inches below ceiling	9.5	"
2 feet below ceiling	6.5	"
4 feet below ceiling	4.5	"
6 feet below ceiling	2.4	"
8 feet below ceiling	2.2	"

Lighting data submitted by E. W. Commery, General Electric Company, Nela Park, Cleveland, Ohio, as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 51 Madison Avenue, New York 10, N. Y.

Performance of Fluorescent Lamps on Leading Power-Factor Circuits

By R. N. THAYER
A. BROWNELL

GENERAL descriptions and characteristics of ballast circuits for fluorescent lamps have already been published in this journal,[1, 2] and elsewhere,[3] and do not need to be repeated here. Of the many possibilities available, the most popular and widely used ballast design for those lamp sizes requiring an open-circuit voltage above the commonly available 110-125-volt supply has been one to operate two lamps. One of these operates from the open-circuit voltage through a series reactor, and both the lamp and circuit are commonly referred to as "lag" since the power-factor of this combination alone is .50-.60 lagging. The second lamp operates through a capacitor and reactor, all in series, with the main voltage drop across the capacitor; this lamp and circuit are known as "lead" because this combination alone has a leading power-factor of .50-.60. The operation of both lamps together gives an input power-factor close to unity, and reduces cyclic flicker in the combined light from both lamps; these advantages account chiefly for the popularity of the twin-unit design, which is estimated in use in over 90 per cent of the 40-watt and 85/100-watt lamp positions.

Certain differences in performance of lamps appear inherent on these two circuits, and so are not subject to the ballast designer's choice. Lamps on lead circuits generally start more slowly than on lag; shift less in current, wattage, and light output with fluctuations in supply voltage; stay operative on lower values of supply voltage, or on momentary dips; warm up to full light output faster; and start under more adverse conditions of supply voltage and ambient temperature. The object of this paper, however, is to cover in detail only the effects on lamp performance of variables in lead circuit design which are available to the ballast engineer, and ultimately to the user by his choices from the commercially available designs.

A paper presented at the Great Lakes Regional Conference of the Illuminating Engineering Society, Rochester, New York, May 24, 1949.

MESSRS. THAYER and BROWNELL are assistant to the technical director and development engineer, respectively, Lamp Development Laboratory, Lamp Department, General Electric Company, Nela Park, Cleveland, Ohio.

TABLE I.—Cathode Preheating Current for Various Circuits. Approximate Preheat Current, in Amperes, at Rated Supply Voltage.

Lamp Size	Lag	Compensated Lead	Uncompensated Lead	Rated Lamp Operating Current Amps
20W	.55	.45	.36	.36
30W	.55	.50	.35	.35
40W	.65	.60	.42	.42
85/100W	2.0	....	1.6	1.6/1.5

TABLE II.—1940 Comparisons of F Lamp Life on Compensated *vs.* Uncompensated Lead Circuits Relative Lamp Life[a]

Lamp Size	No. Lamps per Lot	Comp. Lead	Uncomp. Lead	% Loss, Uncomp. Lead
30W	6	100	73	27
40W	12	100	63	37
40W	12	100	69	31
Total	30 Avg.	100	68	32

[a]On test cycle of 1 hour on, 15 minutes off, with FS-4 glow starters.

Compensated *vs* Uncompensated Lead: Lamp Life

For preheat-start lamps and circuits, the most important available design choice on lead circuits is the inclusion or omission of a starting compensator. Table I shows that lag circuits supply a preheat current about 50 per cent higher than rated lamp operating current; this serves to heat the lamp cathodes to proper incandescent temperature for lamp starting. The simple (uncompensated) lead circuit described above, on the other hand, supplies a preheat current only equal to or slighty greater than operating current, and consequently will not heat the cathodes so fast or so hot as does the lag circuit. Attainment of the desired cathode temperature for starting requires an additional ballast winding, known as a compensator, to increase preheat current (see Table I). If other design variables are held constant, this adds both to the original cost of the ballast and to the cost of wiring its two separate leads in series with the starter circuit. Lamp users may reasonably require justification in better lamp performance for this additional cost and complication over ballast designs not using it.

When the lead circuit and twin unit were first introduced, about 1940, no compensator was used, and numerous early failures were soon noted on lead circuits, as compared with lag. Comparative life tests with and without the compensator, on

lamps and starters then standard, gave the striking results shown in Table II. Some lamp failures on uncompensated lead circuits occurred before 1000 hours on two of the tests. The one-third loss in lamp life in lead circuits resulted in the recommendation which still stands; the use of a compensating winding to obtain normal lamp life.

The successful equalization of lamp life on the two circuits by addition of the compensator to the lead circuit is demonstrated by the fact that life test comparisons on more than 125 lamps on each circuit in the past year have shown only 12 per cent shorter life on lead than on lag circuits. Moreover, this differential can be completely accounted for by small differences in operating current, and so is believed unrelated to any starting differentials.

More recently, a life test of 40-watt lamps was run, in which the only variable between lots was the preheat time permitted at each start per three hours of burning, at a test preheat current of .55 amps. Preheat time was controlled by arrangement of clocks and magnetic relays. Fig. 1 shows the results obtained. Lamp life improves steadily with increased preheating time, up to the point at which end-glow occurs. Beyond this point, our experience indicates that life is unaffected by further heating time, within practical limits. What bearing does this result have on compensated *vs* uncompensated lead circuits? As the top horizontal scale indicates, this curve fundamentally shows the relation between lamp life and cathode preheat temperature at starting, regardless of the current-time combination by which that temperature is reached. Note that about 1.25 seconds at .55 amp. is required to reach 600°C, which is the lowest temperature at which incandescence can usually be seen. Many measurements have been taken recently of the average preheat time of random commercial glow starters on compensated and uncompensated lead circuits. These times, in combination with the measured preheat currents, have been related to cathode preheat temperature by other data not detailed here. The resultant points along the horizontal axis have been marked in the lower right-hand corner of Fig. 1, and again indicate about a one-third reduction in lamp life for uncompensated lead circuits. Since lamp lives are now much longer than in 1940, the omission of a compensator will not result in failures at as few burning hours as then, but the ratio is still valid, along with the proportionate loss of lamp performance and value. Although it is possible that pending or future developments in lamps and/or starters may reduce or eliminate this one-third life differential, our data indicate that it exists to date, and the use of a compensator is, therefore, still recommended.

Compensated *vs* Uncompensated Lead: Other Lamp Performance Variables

Certain other aspects of lamp performance are also poorer if the compensator is omitted. One is the development of greater end-discoloration with long burning. Visual inspection of comparative groups of lamps on one normal life test at 600, 1200 and 2100 hours showed uncompensated-lead lamp ends considerably darker than those of compensated lamps at every interval. On a second normal life test, inspections and ratings were made on an arbitrary scale graded from 0 for clear ends to 6 for maximum discoloration, with the results shown at the top of Table III. Similar estimates were made on a third, accelerated starting test cycle, with the results shown at the bottom of Table III. All test data indicate that the omission of the com-

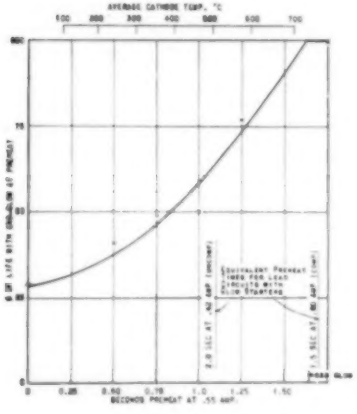


Figure 1. (Left) Effect on 40-watt fluorescent lamp life of cathode preheat time (at .55 amp) and temperature, and equivalent preheat times for compensated and uncompensated lead circuits with average glow starters. Each point is the average of 8-14 lamps.

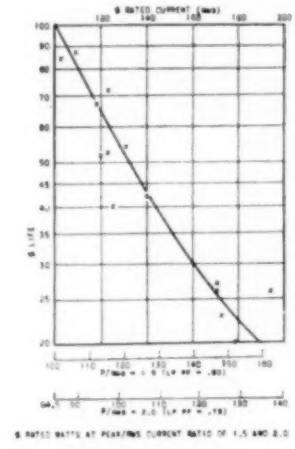


Figure 2. (Right) Effect on 40-watt fluorescent lamp life of high operating current, and corresponding lamp wattages for normal (1.5 peak-RMS ratio) and abnormal (2.0 peak-RMS ratio) current waveshapes. Each point is the average of a group of 5 or 6 lamps.

pensator results in greater end-discoloration. The wide variations in individual lamps and ends, however, make this conclusion true only with respect to averages, and not with respect to every individual lamp.

Another lamp performance handicap resulting from omission of the compensator is slower starting. The top section of Table IV summarizes results obtained from starting ten random lamps once with each of five random FS-4 glow starters on various circuits at both 118 and 106 supply volts. The bottom section of the table summarizes similar results for a second, independent test on five other lamps and starters. Both show slower starting for the uncompensated lead circuit, because the lower preheat current results in slower cathode warmup. Since lag lamps start faster than on either kind of lead circuit, the time required for the first few lamps to light up in an installation will remain unchanged if the compensator is omitted, but the increased spread in starting time for a whole installation will be more noticeable, particularly at low line voltages.

No-blink type starters stop the annoying flashing of deactivated lamps by means of a cut-out mechanism, which is reset either manually or automatically when the wornout lamp is replaced by a new one. Since most of these mechanisms are actuated by preheat current, the reduced current available in uncompensated as compared with compensated lead circuits (Table I) reduces the wattage available to operate the mechanism by more than half, with the expected adverse results on cutout reliability, as shown by tests on ten random FS-40 starters summarized in Table V.

Uncompensated Lead on 85/100W

The several adverse effects arising on 40-watt lamps from omission of the compensator naturally raise the question as to why the 85-watt (formerly the 100-watt) lead circuit is uncompensated, as indicated in Table I. This has resulted from a combination of circumstances. When this size was first commercialized, the main available starter design was the four-contact current-actuated thermal type, FS-64. Lamp life is not so adversely affected by low preheat current on this type because preheat times are better controlled, and can be set long enough that desired cathode preheat temperature is reached at either preheat current. Thus, in the FS-4 thermal starter design for the 40-watt size with which this paper chiefly deals, preheat time at .60 amp is 2.3 seconds, while at .42 amp it is 3.9 seconds. Reference to Fig. 1 and the corresponding times for glow starters will make clear that thermal-start preheat times will result in a much reduced differential in life for compensated *vs* uncompensated lead. A second consideration is that the cathode design developed for this lamp is better preheated by the current from an uncompensated lead circuit than the cathode for the 40-watt. The 40-watt cathode does not lend itself to the same results for reasons connected with its smaller cathode size and current rating.

In the 100-watt size, the pressure of extensive wartime use led to the development and widespread usage of a glow starter, to permit inclusion of the much-desired no-blink feature. This inclusion is more feasible in the glow than in the thermal type. However, the glow starter gives somewhat short preheat times for the large cathode required, and has been recommended for use only where starting is relatively infrequent. If used with glow starters on as frequent a cycle as one start per three hours of burning, lamp life is adversely affected, and life on lead circuits is somewhat less than on lag. Addition of a compensator for such service would equalize life for both circuits.

Lamp Wattage, Current, and Current Waveshape

The compensator problem applies only to preheat-start lamps and circuits, but design variables affecting operating wattage, current, and current

TABLE III.—End-discoloration of 40W F Lamps on Various Circuits. Normal Test Cycle (3 hrs. on, 20 min. off).

	Average Discoloration Rating at 1000 Hrs.	2000 Hrs.	3000 Hrs.
Lag	0.6	0.8	1.0
Comp. Lead	0.8	0.9	1.2
Uncomp. Lead	0.9	1.3	1.9
Accelerated Test Cycle (20 sec. on, 40 sec. off)			
	Average Discoloration Rating at 4000 Starts	**7000 Starts**	**10,000 Starts**
Lag	0.6	1.1	1.6
Comp. Lead	0.2	0.4	0.7
Uncomp. Lead	1.1	1.6	2.3
	% Clean Ends (0 Rating)		
Lag	58	42	25
Comp. Lead	92	75	58
Uncomp. Lead	58	25	8

TABLE IV.—Starting Time of 40W F Lamps on Various Circuits

First Test

Volts	Circuit	% Starts at 5 sec.	10 sec.	15 sec.	Time for ¼ of Lamps to Start
118	Lag	90	95	96	3 sec.
118	Comp. Lead	28	80	96	7 "
118	Uncomp. Lead	2	72	93	7.5 "
106	Lag	78	93	95	4 "
106	Comp. Lead	10	76	86	6.5 "
106	Uncomp. Lead	0	36	75	11 "
Second Test					
118	Comp. Lead	92	100	100	3.5 sec.
118	Uncomp. Lead	64	100	100	4.5 "
106	Comp. Lead	35	98	100	5.0 "
106	Uncomp. Lead	14	96	100	6.5 "

waveshape apply equally to instant-start and preheat-start types. These three variables are interrelated, and the effects of departures from good design values for them are alike for lag and lead circuits. In practice, however, departures have been much more frequent on lead.

Since lamp wattage and light output vary closely in the same proportion in the vicinity of standard ratings, the chief penalty of a ballast that delivers low wattage to the lamp is low light output. Practical manufacturing procedures on ballasts permit holding all individual units within $\pm 7\frac{1}{2}$ per cent of lamp wattage ratings. However, the lead circuits on some commercially available ballast designs deliver lamp wattages as low as 80 per cent of rated, despite rated supply voltage. Obviously, attainment of a desired lighting level with such ballasts will require a proportionate addition in total number of fixtures; otherwise, the first saving in ballast and fixture cost is paid for in a permanently lower level of lighting.

A lamp operating current much above normal results in considerable loss in lamp life. Fig. 2, based on tests of many lamps, shows a two per cent reduction in lamp life for each one per cent increase in lamp operating current, in the vicinity of rated current. The 12 per cent decrease in lamp life from lag to compensated lead circuits, referred to above, is completely accounted for by Fig. 2, since the random ballasts used averaged .39 amp on the lag side and .41 amp on lead, a difference of five per cent. Fig. 2 also furnishes the answer to many inquiries on the penality of operating lamps above rated loading for increased light output. The chief penalty is short life; lamp efficiency is also lower, and end-discoloration more severe. The life-current relationship of Fig. 2 applies specifically to a former standard 40-watt cathode design which has been somewhat modified in the last year, but the same general relationship is expected to hold. It is not known to what extent alternate designs and designs for other lamp sizes duplicate this behavior.

At this point the question may be raised as to why specify the effects of *low* wattage and *high* current. Aren't current and wattage alternative measures of similar things, and approximately in fixed proportion? No, particulraly in lead circuits. Current waveshape may easily be distorted by cost-saving measures in ballast design, with the result that lamp wattage is quite low, despite normal current rating. Alternatively, rated lamp wattage may be met, but only by providing an excess current, with its resultant short life. The two horizontal axes at the bottom of Fig. 2 illustrate this problem. For the peak/RMS current ratio of 1.5 typical of a well-designed lead (or lag) circuit, rated lamp wattage is obtained at rated lamp current, and lamp power-factor has its normal value of about .90. But the cheaply-designed ballast often has a peak/RMS ratio of 2.0, a lamp power-factor of only .75, and a lamp wattage and light output only about 85 per cent of rated. The user loses on either choice — either short life from excess current at rated watts (53 per cent life at 128 per cent current, in Fig. 2) or a 15 per cent loss in light output at rated current and life.

Where lamps are rated, as in the slimline sizes, for operation over a range of currents, cathode design and current range have been suitably matched to provide an acceptable and approximately constant life throughout the rated range. As long as current lies within this range, the life-current relationship of Fig. 2 does not apply. However, the relationship of current to wattage and light output is affected by current waveshape distortion just as shown there. So, the user cannot safely assume that some measured or rated current to the lamp — say 200 ma — means the corresponding rated wattage and light output unless waveshape is good. If peak-RMS current ratio is 2.0, for example, 200 ma may provide only 85 per cent of the rated watts and light output for that current. On the other hand, distorted current waveshape does not result in a short-life penalty unless current exceeds the maximum rated value. Regardless of the adequacy of light output and life, lamp performance problems with excessive flicker and operating instability will occur if peak/RMS current ratio exceeds 2.5.

TABLE V.—Lockout Time of FS-40 Starters on 40W F Lead Circuits

Line V	Preheat Amps	Lockout Time, Seconds Avg.	Range	% Lamps Still Flashing at End of Test (5 Min.)
		Comp. Lead		
118	.39	49	40-65	0
160	.55	56	42-83	0
		Uncomp. Lead		
118	.41	135+	88-300+	10
166	.58	193+	117-300+	20

Conclusion

Fluorescent lamp performance is critically dependent on ballast design. To obtain the quality and performance built into a lamp by its manufacturer, the ballast designer and manufacturer must be particularly careful on lead circuits to meet ballast design recommendations which the lamp manufacturer is best able to determine. Acknowledgment is made to R. L. Keiffer of this Laboratory, and M. A. Lakness, Standardizing Division.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Society for Blindness Relights Headquarters Offices

Deciding to take its own medicine, the National Society for the Prevention of Blindness recently completely relighted its headquarters' offices in New York City. Designed not only to serve for the convenience and efficiency of staff personnel, but to serve also as a practical demonstration to visitors of practical methods of preserving the vision and morale of office workers, the installation provides some 30 to 80 footcandles on working surfaces, according to the nature of the work. The accompanying illustration shows a portion of the general office.

The function and objective of the National Society for the Prevention of Blindness is to promote sight conservation through education, research, and service. As light is essential to effective seeing, and as eye health and efficiency are important factors in work performance, the Society decided that it would be a worthwhile investment to bring the lighting of its headquarters offices up to date to take advantage of advances in lighting equipment and technique that has been made since its former lighting system was installed. Dr. Franklin M. Foote, executive director of the Society, reports that the adoption of an all-fluorescent system of lighting for all areas except hallways was made only "after careful consideration had been given to all aspects of the problems of artificial illumination." The incandescent illumination already installed in the hallways proved adequate under recommended standards.

The area involved consists of a general clerical office, a small reference library, a combined executive office and directors' room, and thirteen staff offices of varying sizes. To enhance the demonstration aspect of the installation, it was decided to install as many different types of luminaires as would assist those visiting the Society offices to determine which type would best suit special needs. Also, in the selection of the type of luminaire for any individual office, the preference of those using the office was considered.

Recessed troffers in combination with partially soundproof ceilings were installed in parallel lines of varying lengths to suit the irregularities of the room shape. A total of 19 two-lamp (40-watt) fixtures were installed. This represents a total of 1520 watts for the 1440 square feet of room area, and is reported as providing from 50 to 80 footcandles on all working surfaces. In the executive office, three 4-lamp (40-watt) luminaires represent 480 watts for the 320 square feet of room area, and are reported as providing 30 footcandles on the working surfaces.

In the other office areas, which range from 98 to 196 square feet, general illumination is reported at not less than 30 footcandles on any working plane, and in most instances 50 footcandles. In offices where intensive eye work is carried on in connection with the continuous use of statistics on causes of blindness, luminaires were installed directly over the desks to provide from 50 to 70 footcandles on the working plane.

In the reference library where no natural light is available, special attention was given to the problem of providing adequate illumination not only for the working planes, but to enable the easy reading of publication titles on the shelves. Here, eight rows of deep troffers of anodized aluminum, each containing two 40-watt lamps for a total of 640 watts, provides approximately 50 footcandles on all surfaces.

To obtain best results from the new lighting installation, careful consideration was given to reflection factors. In all offices, the ceilings and upper parts of the walls were painted a flat white giving a reflection factor of from 80 to 85 per cent. For the lower walls, a flat-finish light grey-green was chosen, giving a reflection factor of approximately 55 per cent. Office furniture and equipment were painted a light grey giving a reflection factor of 30 per cent.

A PORTION OF the general office at the New York City Headquarters of the National Society for the Prevention of Blindness, recently relighted and refinished to provide some 50 to 80 footcandles on working surfaces.

I. E. Mailing Schedule Under Scrutiny

It is one thing to get an issue of ILLUMINATING ENGINEERING off the presses and into the mail sacks on some reasonable schedule. It is quite another thing to get anything like expeditious delivery to the individual member and subscriber.

In an effort to find out just how expeditiously IE is being delivered in different points throughout the United States and Canada, an inquiry was dispatched in June to the chairmen of each of the Society's sections and chapters, and to the Regional Vice-Presidents, requesting information on a return postal card as to the exact date of postoffice delivery of the June issue of ILLUMINATING ENGINEERING in each instance. The June issue, all segregated and placed in mail sacks in accordance with postoffice procedure in order to expedite handling, was placed in the postoffice at Baltimore, Maryland, the 12th of June. The following summary of questionnaire returns shows when it was received:

June 13
Waterloo, Ia.

June 15
Montreal, Quebec, Canada.

June 16
Atlanta, Ga.
Meriden, Conn.
Pittsburgh, Pa.

June 17
Atlanta, Ga.
Buffalo, N. Y.
Indianapolis, Ind.
Joliet, Ill.
Philadelphia, Pa.
Syracuse, N. Y.
Tampa, Fla.

June 18
Vancouver, B. C.

June 20
Cincinnati, Ohio
Cleveland, Ohio
Hamilton, Ontario, Canada
Los Angeles, Calif.
Kansas City, Mo.
Milwaukee, Wis.
New Jersey
New York
Omaha, Nebr.
Pittsburgh, Pa.

June 21
Dallas, Texas.
Detroit, Mich.
Rochester, N. Y.
Ottawa, Canada
New Orleans, La.
New York, N. Y.
Toronto, Ontario, Canada.
Pasadena, Calif.
St. John, N. B., Canada.

June 22
Detroit, Mich.
Montreal, Quebec, Canada
Salt Lake City, Utah
San Antonio, Texas.
Seattle, Wash.

June 23
Charlotte, N. C.
Houston, Texas.

June 24
Nashville, Tenn.

June 25
Vancouver, B. C.

June 27
Baltimore, Md.

June 29
Oakland, Calif.

Efforts are being made to improve this situation.

French Study Mission Visiting U. S. Lighting Firms

A number of lighting equipment manufacturers will be hosts this fall to a group of French lighting engineers who are visiting this country as a study mission under the Marshall Plan. Arriving late this month, the group plans to study on-the-spot American manufacturing processes and lighting application practices.

The lighting study mission group has been organized by the Syndicate of Makers of Electric Lighting and Applied Equipment, of Paris, with Marshall Plan aid for the purpose of introducing the most efficient processes to the lighting industry in France. Many of the leading American firms are cooperating in the project, welcoming the French engineers at their plants.

Headquarters office of I.E.S. has cooperated closely with the group in the technical aspects of their visit, arranging lists of interesting installations in the New York area, and furnishing pertinent published data. If the group arrives in time, they may attend the I.E.S. National Technical Conference in French Lick.

The U. S. National Committee of I.C.I., through L. E. Barbrow, Secretary, has also been in close cooperation with the Syndicate, negotiating arrangements in this country and acting as liaison with manufacturing plants.

Planned Lighting Promotion Committee Formed by EEI

A National Planned Lighting Promotion Committee, which will keep the electrical industry throughout the country informed of new developments in Planned Lighting sales activities, is being formed by the Edison Electric Institute.

The new committee, which will be headed by J. S. Schuchert of the Duquesne Light Company, Pittsburgh, Pa., will be organized on a regional basis, with every section of the United States being represented by a leading figure in lighting promotion.

"This committee will serve as an active clearing house for successful Planned Lighting promotional and educational ideas used in all markets by the various branches and trade associations of the electrical industry, including manufacturers, distributors, contractors, dealers and utilities," Mr. Schuchert said. "Each committee member will sparkplug Planned Lighting activities in his assigned area, acting as the source of new P/L promotional ideas and continually pointing up the long-term benefits resulting from aggressive Planned Lighting promotion to customers and companies alike."

Committee personnel and the areas in which they will serve will be announced soon, Mr. Schuchert said.

National Association of Electrical Distributors Is New Name of NEWA

Effective September 1st, by action of the Board of Governors, the name of the National Electrical Wholesalers Association was changed to National Association of Electrical Distributors, according to an announcement by president D. M. Salsbury and managing director Charles G. Pyle.

The indispensable economic functions of the modern distributor of electrical apparatus, supplies and appliances in the opinion of the Board are more appropriately reflected by the new Association name, which will hereafter also be referred to as N.A.E.D.

Mr. Pyle, in commenting on the historical background of the distributing branch of the electrical industry, provided the following historical resume which is of interest in indicating developments which eventually led to the new trade association name.

"In 1908, at Niagara Falls, Canada, 75 electrical jobbers got together and formed the Electrical Supply Jobbers Association, which was the beginning of the first electrical distribution organization in the United States.

"Battery salts, annunciators, wires, bells, buzzers, arc lamps, etc., were the products of the times, bought in job lots and sold by the then called 'jobbers' of the industry.

"Considerable electrical development occurred between that date and 20 years later, by which time World War I had come and gone, with its great technological advances of those days.

"On June 6, 1928, the Electrical Supply Jobbers Association concluded that so many more new and more intricate electrical devices were then being manufactured and distributed throughout the membership, that National Electrical Wholesalers Association should be its new name to denote the growth in stature from a strictly jobbing function to a more economically stable wholesaling service.

"Similarly, at Cincinnati in May of this year, the question again arose as to the identification of the electrical wholesaler with regard to the distributive function he performs. With the advent and rapid development of fluorescent lighting, industrial electronic devices, air conditioning, food freezers and television, to name only a few products, 'wholesaling' now has been superseded by 'distributing' in terms of modern economic services necessarily required by the manufacturers and contractor-dealer."

The headquarters offices of the National Association of Electrical Distributors will remain at 500 Fifth Avenue, New York 18, New York.

Contest Rules for General Electric Planned Lighting Awards Now Available

Rules governing the recently announced nationwide planned lighting competition sponsored by General Electric's Lamp Department are now available for the guidance of contestants. Booklets covering all details of the contest may be obtained from any General Electric Sales District located in most principal cities, or direct from the Lamp Department headquarters, Nela Park, Cleveland 12, Ohio.

Twenty-one thousand dollars are being offered as prizes for 36 meritorious Planned Lighting installations placed in regular operation in 1949. There will be awards for 24 commercial and industrial lighting installations and for 12 residential installations. These may be for either the initial lighting of the new buildings or the relighting of existing buildings.

The 12 winners of residential lighting awards will be selected by the following judges: Chairman, Caroline E. Horn, Electrical Testing Laboratory, New York City, and chairman, New York Section, I.E.S.; Gladys Miller, interior designer, New York City, and member I.E.S. Residence Lighting Committee; Gladys A. Branegan, Director, School of Home Economics, College of Agriculture, Ohio State University, Columbus, Ohio; Thomas Smith Kelly, lighting consultant, New York City, and member of I.E.S. Residence Lighting Committee. Eugene W. Commery, head of Residential Lighting Section, G-E Lamp Department, will be the technical advisor for the residential lighting awards judges.

Awards of $100 each will be made to individuals who have played key roles in planning, selling, supplying and installing the lighting for the 36 outstanding Planned Lighting installations of 1949 in which General Electric lamps are predominantly used. Additional awards of $150 each will go to persons submitting reports of winning installations.

Frequency Conversion Project in Canada Assumes Vast Proportions

The largest and most lengthy project ever undertaken by the Hydro Power Commission of Ontario (Canada) is now under way. This is the conversion of the entire Province from 25 to 60 cycle operation. The estimated time to complete the conversion is given as 15 years, but by checking the growth of 25-cycle loads as far as economically feasible, it is hoped that the entire project may be completed in 10 or 12 years. Millions of dollars' expenditure is, of course, involved.

A Frequency Conversion Division has been established to engineer, plan, supervise, purchase materials and carry out the actual work, either directly or by contract, necessary

(a) To convert with the consent of the owner, the electrical stations, apparatus, appliances or works of any Rural Domestic Commercial Lighting or Industrial Power consumer so that same will operate successfully at 60 cycles.
(b) To convert or replace all existing single phase and polyphase meters for a Municipal corporation or Municipal commission used for billing purposes if requested by it so that 60 cycle power may be measured with required accuracy.
(c) To convert or replace all Commission-owned single phase and polyphase meters used for billing purposes on the Commission's rural system.
(d) To convert in consultation with the Municipal Systems the electrical apparatus, equipment or works in any Municipal pumping station or street railway system.

A head office staff, which will later total some 220, must be completed, field organizations planned, storehouses erected and mobile equipment obtained. The material collected must be complete in every detail and the work must be planned in perfect timing so that the actual conversion may be done with a minimum of inconvenience to a consumer.

Eventually the Contractor's field personnel will number between 1,700 and 2,000, and approximately 500 cars and trucks will be required for the mobile field forces.

A rough picture of the materials involved would show:

	Total Program
Within the Municipalities (hp)	1,881,000

FLUORESCENT cove lighting is one of the up-to-date features of the want ad office in the new Chicago Tribune quarters.

Domestic, Commercial, Urban, Farm and Hamlet Consumers	772,000
Industrial Consumers	16,000
Industrial load in motors	1,468,000
Domestic Motors	120,000
No. of single phase Meters	820,000
No. of polyphase Meters	24,000
No. of fans	108,000
No. of Clocks	385,000
No. of Radios	802,000
No. of Combination and Record Players	130,600
No. of refrigerators	350,000
No. of Washing Machines	542,000
No. of Fluorescent Lighting Ballasts	250,000

A clearer idea of just what the motor picture alone is may be obtained from the following:

Motors	
Industrial	166,650
Commercial	175,000
Domestic	150,000
Fans	182,082
Refrigerators	300,000
Washing Machines	542,000
Vacuum Cleaners	280,000
10 years	1,800,000
200 days	180,000 (per year)
	900 (per day)

In addition to this must be added all the miscellaneous devices, such as bell ringing transformers, temperature control devices, X-ray equipment, neon and cold cathode transformers, ultraviolet and therapeutic equipultra-violet and therapeutic equipment, ignition transformers, electronic devices, television machines, conversion of radio stations, special frequency changers, street railway stations, etc.

Sylvania Announces Organizational Changes

As a part of its program of organization simplification, Sylvania Electric Products, Inc., has brought the Lighting Fixture and Lamp Divisions together into a single unit to be known as "The Lighting Division." It will operate under the direction of Vice-President Frank J. Healy with headquarters at 60 Boston St., Salem, Mass.

Charles H. Goddard, I.E.S. President-Elect who has headed up the Fixture Division at Ipswich, Mass., for the past two and one-half years, has assumed the responsibility for the entire utility market for all of the company's lighting products.

Stuart Goodwillie, who has been manager of Central Station Sales, has been assigned to the development of large national account business.

Summer Activities of the Sections and Chapters

After a full winter's program of monthly meetings, forums, lighting courses, clinics and contests, most of the Society's Sections and Chapters relax for their last meeting and just feature fun.

The MICHIGAN SECTION, for instance, held their last meeting of the 1948-49 season out of state, at the Jackson Country Club, Jackson, Michigan. The only serious application shown by the 136 members and guests was to the sturgeon and beefsteak dinner which followed the full day golf tournament.

The PITTSBURGH SECTION also turned to golf as a subject for their last meeting late in June, featuring a tournament and dinner at the Mt. Lebanon Golf Club. The meetings' subject attracted a record attendance.

An old-fashioned family-style picnic wound up the season for the SOUTHWESTERN SECTION at Dallas, Texas. Members and guests brought their own box lunch, with beer, soft drinks and ice cream furnished at the Park. Their account of it sounded like fun and frolic for sure—games, races, dancing—and Bingo, natch.

An outing to finish the season is now an annual event for the CONNECTICUT SECTION. By applying the same organizational planning as to the best lighting design problems, the committee furnished an outing which had something for everyone—golf, horseshoes, darts, hoop rolling—and an old-fashioned Connecticut Fish Fry.

Some Sections stayed educational to the end. GEORGIA SECTION featured an "Information Please" program for their final meeting, with J. B. Browder, Regional Vice-President, serving as Quiz Master.

NORTHERN CALIFORNIA SECTION'S last meeting covered "Residential Lighting Problems." This is in line with discussions at the Local Activities Conference, at which it was recommended that home lighting be the subject of at least one meeting each year by each Section and Chapter.

OREGON SECTION in Portland held a luncheon meeting at the Congress Hotel as their last meeting at which Dr. Richard Feinberg, industrial optometrist, spoke on "Illumination, and Vision Conservatism."

Completing their first full year of operation, the MOTHER LODE CHAPTER in Sacramento, California, held a din-

THE SOUTHEAST FLORIDA Chapter received its I.E.S. Charter at a special luncheon meeting held July 7, 1949, at the Seven Seas Restaurant, Miami. Guest Speaker was William B. Shenk, past-chairman of the Florida Chapter. Shown at the ceremonies are, left to right (standing), Mr. Shenk, N. H. Ballinger, Vice-Chairman Southeast Florida Chapter, A. C. Bergh, Chairman, and Earl J. Reeder, Secretary.

ner meeting as their final program, around the subject of "Theatre Lighting." George Smedberg of the Associated Lighting Service, San Francisco, and Raymond H. Rhoades, McClatchy Newspapers and Broadcasting Co., were guest speakers and leaders of the discussion.

ROCHESTER CHAPTER combined business wtih pleasure for their closing meeting. After an afternoon of golf and dinner, and the election of next year's officers, members and guests moved on to the Rochester Gas & Electric Co.'s Russell Station for an inspection trip of this new modern generating plant.

The new SOUTHWEST FLORIDA CHAPTER in Miami, where summer temperatures are apparently more moderate than in the suffering middle west and east, continued their programs well into July and were still going strong at the end of the summer.

The IOWA SECTION, outstanding for its four-a-year full scale conferences, held its Spring Conference, previously washed out in March storms, as its final meeting. A full-day Lighting Conference was held late in June at the Montrose Hotel, Cedar Rapids, at which four important papers were presented. Their excellent program included:

Visual Efficiency and Illumination by Dr. C. C. Koch, Secretary American Academy of Optometry, Minneapolis, Minn.

Louvered Ceiling Lighting by Steven Furbacher, Sales Supervisor Central Division, Kawneer Co., Niles, Mich.

The Economics of Lighting by Leonard V. James, Consultant, Lamp Dept., General Electric Co., Chicago, Ill.

What Next—Soures & Application by Carl F. Jensen, District Engineer, Westinghouse Electric Corp., Chicago, Ill.

Completing the program in the evening was a banquet and entertainment held in the ballroom of the hotel.

LIGHTING CALENDAR

Society Events

September 19-23, 1949—National Technical Conference, French Lick Hotel, French Lick, Ind.

Industry Events

September 26-28, 1949—National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

October 11-14, 1949—American Standards Association, Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

October 12-15, 1949—International Association of Electrical Leagues Fourteenth Annual Conference, Cleveland, Ohio.

October 13, 1949—Fifteenth Anniversary Celebration of Better Light Better Sight Bureau and Testimonial Dinner for Glenn Trumbull, New York City.

October 24-28, 1949—37th National Safety Congress, Chicago, Ill.

November 6-8, 1949—Southeastern Industrial Vision Congress, Georgia Institute of Technology, Atlanta, Ga.

November 8-14, 1949—National Electrical Contractors Association 1949 Annual Convention, Rice Hotel, Houston, Texas.

November 14-18, 1949—National Electrical Manufacturers Association, Chalfonte-Haddon Hall, Atlantic City, N. J.

December 4-7, 1949—The American Society of Refrigerating Engineers, 45th Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

December 26-31, 1949—Meetings of the American Association for the Advancement of Science, Hotel Statler, New York, N. Y.

Fluorescent Lamps Should Have Been Developed First

Fluorescent and phosphorescent materials were known to scientists of old who observed the brilliant colors of fluorspar or the glow of calcined shells or calcium minerals in volcanic regions. Almost half a century before incandescent lamps were being studied by Edison and others, Sir David Brewer in 1833 experimented with solutions of chlorophyll, the green coloring matter in leaves, because he observed that when sunlight fell on the mixture, there was created a mysterious red ribbon of fluorescent light. Delays in the technique of generating ultraviolet radiations largely account for the delays of many decades before these early principles were combined into a practical illuminant.

Daylighting Report Out for Letter Ballot

As this issue of ILLUMINATING ENGINEERING goes to press, the final draft of the Recommended Practice of Daylighting in final draft form is being circulated to members of Council for letter-ballot in accordance with the preliminary action taken by Council at its June meeting.

One of the oldest and most active committees of the Society is the Daylighting Committee. Numbered among its members have been presidents and members of Council. They have sponsored numerous studies and papers on the control and design of natural lighting. Rules that they have developed have been incorporated in State and National regulations and have appeared in the Society's Recommended Practices.

For the first time in their 25 years' existence, they have developed a "Recommended Practice of Daylighting." Their leadership became concerned with the brightness relationships and their share of responsibility toward the proper balance in the luminous environment. They also felt a responsibility concerning the treatments of daylighting that were and would be appearing from time to time in the Recommended Practices for schools, offices, industry and homes. They therefore set up this new report on the basis of major subdivisions which would cover these locations. Supplementing the text matter, designed information and calculations are given in appendices for handy reference and use. A comprehensive bibliography of 200 reference items will assist those interested in making specific studies.

When the report is approved, it is expected to be scheduled for publication in ILLUMINATING ENGINEERING in due course.

Illuminating Engineering Reprints

To provide readers as well as authors with quantities of reprints of articles, type for this issue of ILLUMINATING ENGINEERING will be held for about four weeks following publication. Orders should be submitted to the Publications Office, Illuminating Engineering Society, 51 Madison Avenue, New York 10, N. Y.

ABOUT PEOPLE

Eric E. Ackland, Vice-President of the Pacific Northwest Region, has recently organized his own company, Eric Ackland & Associates Ltd., with offices in Calgary and Vancouver. This is a manufacturers' agency for fluorescent fixtures serving the Provinces of British Columbia and Alberta.

R. J. Diefenthaler is succeeding Leonard V. James, retired, in the Lamp Department of General Electric Company. **William G. James**, Leonard James' son, entered the Lamp Development Laboratory on June 10 as a permanent employee. Since his graduation from the University of Illinois in 1948, he has been in the scientific training program with General Electric Company.

E. Roland Schoch will sail August 25 for Manila to become technical adviser to the Philippine Electric Manufacturing Company, a lamp-making licensee of the Westinghouse Electric International Company. A nucleus of 50 employees is being trained to produce fluorescent lamps and production is scheduled for the end of the year. Three Philippine Electric men, two of them Filipino, have been trained in Westinghouse lamp plants at Bloomfield, N. J., and Fairmont, W. Va., and in Canada, to serve in the new plant.

Three new sales districts have been established, effective September 1, in the sales organization of General Electric's Lamp Department. The new districts, their locations and managers are: Connecticut Valley Sales District, New Haven, Conn., with **Elbert A. Hawkins** as manager; Texas Gulf Sales District, Houston, Texas, with **George S. Trotter** as manager; Puget Sound Sales District, Seattle, Wash., with **Lloyd R. Wilson** as manager. Mr. Wilson, who has been manager of the North Pacific Sales District, Portland, Ore., will be succeeded in that position by **Walter J. Pitblado**, formerly manager of the Portland Service District. **Alex C. Ham** has been named Portland Service District manager.

The establishment of a new Chicago District with **Andrew G. Nelsen** as manager was announced recently by Westinghouse Lamp Division, Bloomfield, N. J. **Adolph Frankel**, who has served the Westinghouse Lamp Division in various executive capacities, has been appointed to succeed Mr. Nelsen as manager of the Division's Northwestern District, covering nine states and parts of two others. Both men will make their headquarters in Chicago at 20 North Wacker Drive effective August 1.

F. H. Heintz has been appointed Division Sales Manager of the Southwestern Division, Sylvania Electric Products, Inc. Mr. Heintz, formerly Assistant Division Sales Manager in Chicago, will have his offices in Kansas City, Mo. He replaces **J. C. Hicks**, who has been appointed Sales Manager of Sylvania's Canadian subsidiary, Sylvania Electric (Canada) Ltd. Mr. Heintz joined the company in 1940 as a specialist in lighting fixtures. During the war he handled engineering projects for Sylvania's Electronics Division, returning to the Lighting Sales Division in Chicago as a salesman when his war work was finished.

Appointment of **H. L. Schreiner** as Field Representative in its Los Angeles Division office has been announced by Sylvania Electric Products Inc. Mr. Schreiner was formerly with the Rheem Manufacturing Company, South Gate, Calif., as Sales Promotion Manager in the Los Angeles area, and with Douglas Aircraft Company as assistant supervisor in its Santa Monica plant. An honor graduate of the University of California at Los Angeles, Mr. Schreiner served three years in the Navy during the war. He attended the California Institute of Technology for two years under the Navy V-12 program, becoming cadet battalion commander and late rserving as a pilot.

The appointment of **N. O. "Pappy" Reed** representing Day-Brite Lighting, Inc., has been announced. He will maintain headquarters in Houston, Texas. After leaving Southern Methodist University in 1928, Mr. Reed joined the Dallas Power & Light Company, where he remained from 1928 until 1931 and again from 1938 (except for Army service) until his affiliation with Day-Brite.

The United States National Committee of the International Electrotechnical Commission announced the election fo **P. H. Chase**, an I.E.S. member, as a Vice-President of their organization. Mr. Chase is chief engineer at the Philadelphia Electric Company.

F. Malcolm Farmer, Vice-President of Electrical Testing Laboratories, Inc., has been elected President of the Company. He has been connected with Electrical Testing Laboratories, Inc. activities since 1903, becoming Chief Engineer in 1911 and Vice-President in 1929. Mr. Farmer has long been identified with engineering activities, having served as President, American Society for Testing Materials (1924-25); President, American Welding Society 1926-28); Chairman, Engineering Foundation (1936-39); President, American Institute of Electrical Engineers (1939-40), and President, United Engineering Trustees (1943-45). During the last war Mr. Farmer served as Technical Consultant on Inspection Methods, New York Ordnance District, U. S. Army 1942-45, and was awarded a War Department Certificate for his services.

J. G. Morrow, Metallurgical Engineer for the Steel Company of Canada, Ltd., Hamilton, Ontario, was elected President of the American Society for Testing Materials, for a one year term at the Annual Meeting of the Society held the week of June 27.

H. McKinley Conway, Jr. has been named as the first Director of the fast-developing Southern Association of Science and Industry, a regional non-profit, non-political organization devoted to promotion of industrial research as a solution to Southern economic problems. The new Director is a native of Alabama, holder of two engineering degrees from Georgia Tech, author of numerous scientific works, and a leader in the movement to improve Southern technology.

Don Ingwersen, formerly with the Sola Electric Company, has been named Sales Manager of the Illuminating Engineering Co. of Hazel Park, Mich. Mr. Ingwersen had previously been on the staff of the Chicago Lighting Institute, served as in-

structor in the CLI lighting courses, and has been active in I.E.S. affairs.

F. J. Healy has been appointed president of the new Canadian subsidiary of the Sylvania Electric Products Inc., recently formed at Drummondville in the Province of Quebec. Other officers appointed to the new plant are **R. H. Bishop** as vice-president; **William O'Keefe**, secretary; and **M. F. Balcom**, treasurer. Mr. O'Keefe, who was general foreman at the Danvers, Mass., plant of Sylvania, will manage the Canadian plant, while **J. C. Hicks**, formerly Kansas City, Missouri, division manager, has been named sales manager, with offices in Montreal.

G. E. Wehner, formerly of the Pittsburgh offices of the Illuminating Engineering Co., Hazel Park, Mich., has been named Factory Representative of the new plant established by that company through its recent purchase of the manufacturing facilities of the General Luminescent Corp.

James F. Fairman, vice-president of the Consolidated Edison Co. of New York, Inc., New York, N. Y., was elected President of the American Institute of Electrical Engineers for the year beginning August 1, 1949, as announced at the annual meeting of the Institute held in Swampscott, Mass., June 22. The other officers elected were: Vice-Presidents, C. G. Veinott, Lima, Ohio; W. J. Seeley, Durham, N. C.; W. C. DuVall, Boulder, Colo.; Ralph A. Hopkins, Los Angeles, Calif.; A. H. Frampton, St. Catherines, Ont., Canada.

M. W. Ross, illuminating engineer with the Commonwealth Edison Co., was elected as Chairman of the Technical Committee of the Chicago Lighting Institute on June 6. Mr. Ross succeeds E. D. Tillson, who had served in this same capacity from the time the Institute was organized in 1930 until his recent retirement from the Commonwealth Edison Co. In addition to his services to the Chicago Lighting Institute, Mr. Ross is an active committee member in the Illuminating Engineering Society, serving currently with the Committee on Store Lighting and with the I.E.S. Sports and Recreational Lighting Committee. Every member firm of the Chicago Lighting Institute has a representative on the Technical Committee. They are: Benjamin Benson for the Benjamin Electric Mfg. Co., R. J. Diefenthaler for General Electric Co. Lamp Dept., William Foulkes for Curtis Lighting, Inc., G. K. Hardacre, Public Service Co. of Northern Illinois, Carl Jensen, Westinghouse Electric Corp., J. C. Malone, Sylvania Electric Products Inc., M. W. Ross, Commonwealth Edison Co., C. W. Zersen, Chicago Lighting Institute.

Garlan Morse, formerly general merchandise manager for the Lamp Division of Sylvania Electric Products Inc., has been appointed director of Pacific Coast Sales for all product divisions of the company, according to a recent announcement. Mr. Morse will make his headquarters in San Francisco.

A. E. Rowe has been appointed assistant manager of the Ballast Sales Division of General Electric's Specialty Transformer and Ballast Divisions. In this new position Mr. Rowe will continue close association with the sale of ballasts for fluorescent lamps upon which he has concentrated his efforts since coming to the General Electric Co. in 1946.

A number of executive changes have been announced by Gwilym A. Price, president of the Westinghouse Electric Corp. Four major personnel assignments were announced involving new or substantially altered responsibilities at the vice-presidential level. **L. E. Osborne** has been assigned staff supervision over all the company's manufacturing activities, including all matters of production and industrial relations. Simultaneously he retains operating responsibility for five major manufacturing divisions.

James H. Jewell, recently-elected vice-president of Westinghouse, takes over staff supervision of all sales and marketing on a company-wide basis.

John K. Hodnette, vice-president and head of the Transformer Division at Sharon, Pa., becomes general manager of industrial products of the Westinghouse plant at Pittsburgh. His successor at Sharon has not yet been announced.

John M. McKibben, also a recently-elected vice-president of Westinghouse and former head of advertising and sales promotion, now is appointed general manager of consumer products with responsibility for operating and distribution of the Appliance Division and the Home Radio Division. Mr. McKibben will make his headquarters at Pittsburgh.

Appointment of **John C. Ringland** and **John D. Colombo** to the Detroit Divisional offices of Sylvania Electric Products Inc., has recently been announced by that company. Mr. Ringland, previously associated with Kurt Versen Lighting Co., has been named a district engineer in Sylvania's Detroit Division, while Mr. Colombo, who has been representing a number of manufacturers for the past few years, becomes a field representative.

J. M. Bennan has been named president of the Jefferson Electric Co., of Belwood, Illinois, according to a recent announcement. Mr. Bennan succeeds James C. Daley, formerly president of Jefferson Electric, who has been appointed Chairman of the Board. Other appointments announced by the company included **John R. Ford** as vice-president and general sales manager, L. Mauerer, vice-president in charge of engineering, **W. S. Minter**, treasurer, and **V. E. Lee**, secretary.

Charles A. Burton, formerly assistant general sales manager of the Lamp Division of Sylvania Electric Products Inc., has been appointed product sales manager of that division. Mr. Burton will make his new headquarters at Salem, Mass.

The appointment of **Charles D. White** of Boston, Mass., as agent in the New England states for the sale and distribution of Advance Transformer Company of Chicago, has recently been announced by that company.

IT SEEMS TO ME

To the Editor:

In presenting possibilities for more profitable lamp merchandising in the department stores reached every month by *Department Store Economist*, we are emphasizing the following factors:

1. The need for educating the public that the lamp is primarily a light source.

2. Adequate home lighting can be introduced most effectively and economically through lamps when they are sold as light sources; but the problem of good home lighting will never be resolved if stores continue to sell lamps as bric-a-brac.

3. A lamp, or pair of lamps, or group of lamps should be sold for the contribution they can make to the overall lighting of a specific room.

4. A lamp should be presented first of all as a light source and its light power should be specifically explained (incandescent, fluorescent or combinations). Then it may be discussed as a table or desk accessory, or as a room necessory if it is on a floor standard. The multiple sale should be aimed at in all lamp presentations. Not one lamp—pairs of lamps at least.

5. Lamps for the dressing table, for the beside table, for bookshelves should always be sold as auxiliary lighting units.

6. Too little of the copy in any lamp advertising is concerned with the lighting value of the lamp.

7. The various styles in bases and shades have far too much attention, and in fact are so played up in advertising that the public as a result has lost track of the lamp's major function, as a light source.

8. Smart homemakers who have learned the cleverest ways to achieve good interiors at low cost have long ago learned that a perfectly adequate light source can be set up on a cardboard pillar—and with a big shade makes a handsomer lamp than can be bought at many, many times the price. She has learned to introduce light into her home through the cheapest possible means, and incidentally, gets better effects than the professional interior decorator gets at enormous fees. Lighting is so simple! Every room should enjoy the blessing of good light, but until the public gets over its confusion about lamps and learns something about light sources, few rooms will be well lighted.

DORIS BURRELL, Managing Editor,
Department Store Economist,
New York, N. Y.

CONTRIBUTIONS to this department are invited from Society members and subscribers, expressing opinions or suggestions relative to published articles, technical papers, or other subjects of professional interest in the lighting field. Although *Illuminating Engineering* will endeavor to publish as many as possible, the right is reserved to publish any letter in whole or in part or to reject it entirely. Statements in letters published are expressly understood to be made by the writers, and publication here does not constitute endorsement or recognition by the I.E.S. Letters submitted for publication should be concise typewritten double-spaced originals, not carbon copies, and must carry signature and affiliation of writer. Illustrations will be considered; line sketches or diagrams should be furnished in duplicate, one inked and unlettered, the other with proper lettering; captions should be furnished.

Photoelectrically-Controlled Street Lights Installed at New Milford, Conn.

The world's first major installation of street lights which are individually self-controlled by photoelectric cells was completed recently at New Milford, Conn. Consisting of 190 luminaires, which turn themselves on and off singly and automatically as conditions of visibility demand, the new street-lighting system covers an area of about one square mile in the New England town and includes seven miles of road and streets.

The photoelectric control built into the luminaires is set so that the lights go on when the prevailing natural light level wanes to one footcandle. They turn themselves off again when the natural light goes above this level. According to F. H. Linsley, engineer for the Connecticut Light and Power Co., who engineered the installation, the maximum time which elapses between the first and the last light going on is about five minutes.

Installed at a minimum height of 25 feet, the new luminaires are mounted on pipe brackets which provide overhangs ranging from 4 to 16 feet, depending upon the street width. Average spacing of the lights is 300-400 feet in the residential sections and 150 feet in the business district.

Current Articles on Lighting

The following list presents titles and source of publication of current articles on lighting and allied subjects which have appeared in recent issues of nationally known magazines having a wide circulation.

Beryllium and the "Bazooka," *Industrial Bulletin*, May, 1949, p. 9

Effective Stage Lighting—II, by Leland H. Watson, *American School Board Journal*, May, 1949, p. 38

Disposal of Fluorescent Lamps, *American School Board Journal*, May, 1949, p. 42

Then Design a Perfect Classroom, by Arthur W. Prinaulx, *American School Board Journal*, May, 1949, p. 45

Lighting the Intramural Field at the University of Texas, by John A. Focht, *Wood Preserving News*, May, 1949, p. 54

Good Lighting and Its Relation to Health, by Ernest A. Watkinson, *Electrical News and Engineering*, May 15, 1949, p. 56

Application of Electricity to Signalling for Road Transport, by G. F. Sinclair, *The Proceedings of the Institution of Electrical Engineers*, Part I, May, 1949, p. 178

A Provisional Standard Observer for Low Level Photometry, by K. S. Weaver, *Journal of the Optical Society of America*, April, 1949, p. 278

Traffic Safety Lighting, by J. W. A. Bollong, *Traffic Engineering*, July, 1949, p. 475

Sports Lighting, by D. E. Beard, *Light and Lighting*, June, 1949, p. 145

Some New Terms in Photometry and Illumination, *Light and Lighting*, June, 1949, p. 155

Modern Plastics in Lighting Development, by K. A. Butcher, *Building and Engineering*, May 24, 1949, p. 81

Color for Industrial Safety, *Standardization*, July, 1949, p. 176

Case History of the Standards on Electric Discharge Lamps, by George L. Diggles, *Standardization*, July, 1949, p. 182

How "All-Glass" Sealed-Beam Automobile Headlamps are made, by Luke L. Stager, *The Glass Industry*, July 1949, p. 387

Australian Glass Louvre Windows to Receive Greater Distribution, *The Glass Industry*, July 1949, p. 410

Cadmium-Mercury Vapor Lamps: Present Status, by Henry B. Sellwood, *International Projectionist*, July, 1949, p. 8

Fluorescent Train Lighting, *I.E.S. Lighting Review* (Australia), April, 1949, p. 6

Daylighting for Hospitals, by Isadore Rosenfield, *I.E.S. Lighting Review* (Australia), April, 1949, p. 8

Lighting in Film Production, by R. D. Hansen, *I.E.S. Lighting Review* (Australia), April, 1949, p. 12

Split Beam Searchlight, *I.E.S. Lighting Review* (Australia), April, 1949, p. 14

The Colour of Fluorescent Lamps, by W. Harrison, *Transactions of the Illuminating Engineering Society* (Great Britain), Volume XIV, No. 6, 1949, p. 145

Difficult Seeing Becomes Easy Under Engineered Lighting, *Electrified Industry*, July, 1949, p. 19

Beverley Minster Lighting, *Electrical Review*, June 24, 1949, p. 1086

Continued on page 20A

SUSTAINING MEMBERS

Acme Electric Corp.
Cuba, N. Y. *J. A. Comstock*

Admiral Lamp Manufacturing Corp.
2430 So. Ashland Ave., Chicago, Ill. *F. Schwartz*

Advance Transformer Co.
1122 W. Catalpa Ave., Chicago 40, Ill. *Hirsch Epstein*

Alabama Power Co.
Birmingham, Ala. *George L. Morris*

All Bright Electric Products Co.
3917-25 N. Kedzie Ave., Chicago 18, Ill. *Max Klein*

Amalgamated Electric Corp., Ltd.
384 Pape Ave., Toronto, Ont., Canada *D. W. Patterson*

American Concrete Corp.
4727 North Lamon Ave., Chicago 30, Ill. *J. W. Lewis*

American Fluorescent Corp.
5407 Broadway, Chicago, Ill. *William Rusnak*

American Sterilizer Co.
Erie, Pa. *Horace Wm. Alexander*

Appleton Electric Co.
1701-1739 Wellington Ave., Chicago 13, Ill. *Nils A. Tornblom*

Arkansas Power & Light Co.
Simmons National Bldg., Pine Bluff, Ark. *Max Sudduth*

The Art Metal Co.
1814 E. 40th St., Cleveland 3, Ohio *George E. Glatthar*

Artistic Lamp Manufacturing Co., Inc.
395 Fourth Ave., New York 16, N. Y. *Myron Perlmutter*

Bausch & Lomb Optical Co.
Rochester 2, N. Y. *David L. Williams*

Benjamin Electric Mfg. Co.
Des Plaines, Ill. *John H. Waterbury*

Blue Ridge Glass Corp.
Kingsport, Tenn. *J. H. Lewis*

Board of Water and Electric Light Commissioners
116 W. Ottawa St., P.O. Box 570, Lansing 3, Mich. *John D. Malnight*

Boston Edison Co.
39 Boylston St., Boston 12, Mass. *R. B. Brown, Jr.*

Bright Light Reflector Co., Inc.
Fairfield & State, Bridgeport 5, Conn. *C. E. Scholl*

British Columbia Electric Rwy. Co., Ltd.
570 Dunsmuir St., Vancouver, B. C., Canada *H. N. Walters*

Brockton Edison Co.
36 Main St., Brockton 67, Mass. *W. A. Forbush*

Buffalo Niagara Elec. Corp.
Buffalo 3, N. Y. *Jack F. Parsons*

Edward F. Caldwell & Co., Inc.
101 Park Ave., New York 17, N. Y. *E. T. Caldwell*

California Electric Power Co.
P.O. Box 512, Riverside, Calif. *W. E. Vaughn, Jr.*

Cal-Lite, Inc.
12600 S. Yukon Ave., Hawthorne, Calif. *N. L. Ureles*

Calpa Products Co.
4116 Chester Ave., Philadelphia 4, Pa. *Paul C. Calisti*

Cambridge Electric Light Co.
46 Blackstone St., Cambridge 39, Mass. *Reginald H. Bowman*

Canadian General Elec. Co., Ltd.
212 King St., Toronto, Ont. *R. M. Love*

Canadian Laco Lamps, Ltd.
745 Guy St., Montreal, Que. *J. Thomas*

Canadian Line Materials, Ltd.
Postal Station H, Toronto 13, Ont., Canada *L. E. Messinger*

Central Hudson Gas and Elec. Corp.
50 Market St., Poughkeepsie, N. Y. *H. E. Dexter*

Central Illinois Light Co.
316 Jefferson Ave. S., Peoria 2, Ill. *R. K. Dallas*

Central Illinois Public Service Co.
607 E. Adams St., Springfield, Ill. *B. L. Palm*

Central Maine Power Co.
9 Green St., Augusta, Maine *Roland W. Hess*

Central New York Power Corp.
300 Erie Boulevard W., Syracuse, N. Y. *L. D. McCormac*

Central Power & Light Co.
P.O. Box 2121, Corpus Christi, Texas *James M. Williams*

Champion Lamp Works Div. of Consolidated Electric Lamp Co.
600 Broad St., Lynn, Mass. *Ellery H. Raddin*

Cincinnati Gas & Electric Co.
Fourth & Main Sts., Cincinnati 1, Ohio *J. R. Hartman*

Circlite Corp.
118 So. Clinton St., Chicago, Ill. *George Gomberg*

City of Burbank, California Public Service Department
174 W. Magnolia Boulevard, Burbank, Calif. *J. H. McCambridge*

City of Glendale Public Service Dept.
119 N. Glendale Ave., Glendale 6, Calif. *P. Diederich*

City of Riverside Electric Light Dept.
3854 Mulberry St., Riverside, Calif. *L. W. Grayson*

City of Seattle, Dept. of Lighting — Puget Sound
1015 Third Ave., Seattle 4, Wash. *P. C. Spowart*

City of Tacoma, Light Division
Tacoma 2, Wash. *Ray H. Weston*

Colonial Electric Products Co., Inc.
1-115 Market St., E. Paterson, N. J. *Wallace M. Woodworth*

Colonial Premier Co.
466 W. Superior St., Chicago 10, Ill. *Richard Weis*

Commercial Light Co.
841 W. Washington Blvd., Chicago, Ill. *Michael R. Fine*

Commonwealth Edison Co.
72 W. Adams St., Chicago 90, Ill. *Ralph G. Raymond*

The Connecticut Light & Power Co.
250 Freight St., Waterbury 91, Conn.

Consolidated Edison Co. of N. Y., Inc.
4 Irving Place, New York 3, N. Y. *Clarence Law*

Consolidated Gas, Elec. Light & Power Co. of Baltimore
100 W. Lexington St., Baltimore 1, Md. *R. H. Tillman*

Consumers Power Co.
212 Michigan Ave. W., Jackson, Mich. *D. E. Kern*

Consumers Public Power Co.
1452-25th Ave., Columbus, Nebraska *W. H. Sinke*

Corning Glass Works
Corning, N. Y. *A. S. Tylor*

Coyne Electrical School, Inc.
500 So. Paulina St., Chicago 7, Ill. *John Hanan*

Crescent Electric Supply Co.
765 Iowa St., Dubuque, Iowa *Titus B. Schmid*

Crouse-Hinds Co.
Syracuse 1, N. Y. *A. H. Clarke*

Crouse Hinds Co. of Canada, Ltd.
7 Labatt Ave., Toronto, Ont. *F. R. Jeffery*

Curtis Lighting, Inc.
6135 W. 65th St., Clearing Station, Chicago 38, Ill. *Darwin Curtis*

Curtis Lighting of Canada, Ltd.
195 Wicksteed Ave., Leaside, Toronto 12, Ont. *H. L. Wright*

Cutler Light Manufacturing Co.
3026-28 N. 22d St., Philadelphia 21, Pa. *Robert T. Cutler*

Dallas Power & Light Co.
1506 Commerce St., Dallas 1, Texas *W. G. Moore*

Day-Brite Lighting, Inc.
5401 Bulwer St., St. Louis 7, Mo. *D. J. Biller*

The Dayton Power & Light Co.
25 No. Main St., Dayton, Ohio *H. S. Nonneman*

Dazor Manufacturing Corp.
4483 Duncan Ave., St. Louis 10, Mo. *P. L. Read*

Delaware Power & Light Co.
600 Market St., Wilmington 99, Del. *W. A. F. Pyle*

Dept. of Water & Power, City of Los Angeles, Bur. of Power & Light
Box 3669 Terminal Annex, 207 So. Broadway, Los Angeles 54, Calif. *C. P. Garman*

Detroit Edison Co.
2000 Second Ave., Detroit 26, Mich. *L. E. Tayler*

Detroit Steel Products Co.
2250 E. Grand Blvd., Detroit 11, Mich. *W. Clifton Randall*

E. I. duPont de Nemours & Co., Inc. (Fabrics & Finishes Div.)
Wilmington 98, Del. *S. W. Quisenberry*

Duquesne Light Co.
435 Sixth Ave., Pittsburgh 19, Pa. *G. W. Ousler*

Duro Test Corp.
2321 Hudson Blvd., North Bergen, N. J. *James L. Cox*

Eastern Fixture Co., Inc.
170 Vernon St., Boston 20, Mass. *Louis Gilman*

East Side Metal Spinning & Stamping Corp.
1 W. 34th St., New York 1, N. Y. *M. A. Kremer*

(*Note*: Names of Official Representatives appear in Italics)

Huasco Services, Inc.
2 Rector St., New York 6, N. Y.
W. E. Parrott

Electrical Information Publications, Inc.
20 E. Mifflin, P.O. Box 232, Madison, Wis.
W. N. Dudley

Electrical Testing Laboratories, Inc.
79th St. & East End Ave., New York City 21, N. Y. *Preston S. Millar*

Elec. Service Mfg. Co.
17th & Cambria Sts., Philadelphia 32, Pa.
E. A. Leinroth

Electric Supply Corp.
701 W. Jackson Blvd., Chicago 6, Ill.
L. B. Mangiane

Electro Manufacturing Corp.
2000 W. Fulton St., Chicago 12, Ill.
L. K. Schoenbrod

Electrolier Mfg. Company, Ltd.
5849 Boyer St., Montreal, Que., Canada.
John Isenman

Ender Manufacturing Corp.
260 West St., New York 13, N. Y.
Jules Levenstein

Electron Corp.
4501 Galapago, Denver, Colo. *Floyd Vickers*

Englewood Electrical Supply Co.
5801-03 So. Halsted St., Chicago, Ill.
Ray O'Leary

Famous Fluorescent Light Co.
762 N. Ogden Ave., Chicago 22, Ill.
Jack R. Stone

Federal Electric Company, Inc.
8700 S. State St., Chicago, Ill.
John H. Gockel

Fitchburg Gas & Electric Light Co.
537 Main St., Fitchburg, Mass. *A. G. Neal*

Fluorescent Equipment & Mfg. Co.
2570 Superior Ave., Cleveland 14, Ohio
Leonard S. Freeman

Fluorescent Maintenance Co., Inc.
1480 S. Robertson Blvd., Los Angeles 35, Calif. *Leonard K. Black*

Fluores-O-Lite Co.
Evans Terminal, No. Broad St., Hillside, N. J.
Meyer H. Silverman

The Fostoria Pressed Steel Corp.
Fostoria, Ohio *E. L. Bates*

H. A. Framburg & Co.
3320-28 Carroll Ave., Chicago 24, Ill.
Stanley A. Framburg

The France Mfg. Co.
10325 Berea Rd., Cleveland 2, Ohio
J. H. Mayne

The Frankelite Co.
1425 Rockwell Ave., Cleveland 14, Ohio
Dave Frankel

Franklin Design Service, Division of Safeway Stores, Inc.
4th & Jackson Sts., P.O. Box 660, Oakland 4,
Wallace H. Lane

The Frink Corporation
27-01 Bridge Plaza North, Long Island City, N. Y. *Theo. J. Brassel, Jr.*

Gallagher-O'Brien Electric Co., Inc.
712 N. State St., Chicago 10, Ill.
Frank A. Gallagher

Garden City Plating & Mfg. Co.
1750 No. Ashland Ave., Chicago 22, Ill.
G. G. Harney

General Electric Co., Apparatus Dept.
River Works, 920 Western Ave.,
West Lynn, Mass. *A. F. Dickerson*

General Electric Co., Lamp Dept.
Nela Park, Cleveland 12, Ohio
Willard C. Brown

General Electric Supply Corp.
1260 Boston Ave., Bridgeport, Conn.
W. W. Booth

General Lighting Products Co.
16 Delancy St., Newark 5, N. J.
Nathan H. Eglowstein

General Outdoor Advertising Co., Inc.
515 So. Loomis St., Chicago, Ill. *E. E. Nevius*

The Georgia Power Co.
Electric Building, Atlanta 1, Ga.
Charles A. Collier

Gibson Manufacturing Co.
1919 Piedmont Circle, N. E., Atlanta, Ga.
R. R. Gibson

Gill Glass & Fixture Co.
Amber & Tioga Sts., Philadelphia 34, Pa.
C. A. Gill

Gillinder Brothers, Inc.
Erie & Liberty Sts., Port Jervis, N. Y.
J. Fletcher Gillinder

Gleason-Tiebout Glass Co.
99 Commercial St., Brooklyn 22, N. Y.
Charles W. Gleason

Globe Lighting Products Co., Inc.
397 Seventh Ave., Brooklyn, N. Y.
Isidor Rosenblatt

Golde Manufacturing Co.
1214 West Madison, Chicago 7, Ill.
E. W. Goldberg

Grand Rapids Store Equip. Co.
1340 Monroe Ave., N. W., Grand Rapids 2, Mich. *Kenneth C. Welch*

Graybar Electric Co., Inc.
420 Lexington Ave., New York 17, N. Y.
Raymond C. Kinney

Gulf States Utilities Co.
Box 2951, Beaumont, Texas *Clarence Barron*

The Edwin F. Guth Co.
2615 Washington Ave., St. Louis 3, Mo.
Fred E. Guth

Hartford Electric Light Co.
266 Pearl St., Hartford 3, Conn.
Victor Ouellette

Hawkins Electric Co.
1447 Washington Blvd., Chicago 7, Ill.
R. R. Hill

Hendrickson-Heffernan Co., Inc.
45-17 Pearson St., Long Island City 1, N. Y.
Joseph T. Manucia

Holdenline Co.
2301 Scranton Rd., Cleveland 13, Ohio
H. E. Ingraham

Holophane Company, Inc.
342 Madison Ave., New York 17, N. Y.
H. L. Logan

Houston Lighting & Power Co.
P.O. Box 1700, Houston 1, Texas
H. O. Clarke

Hydro-Electric Power Comm. of Ont.
620 University Ave., Toronto, Ontario.
R. L. Hearn

Hyland Electrical Supply Co.
700 West Jackson Blvd., Chicago, Ill.
Chas. H. Weicensang

Illinois Power Co.
134 East Main St., (L Box 511 B), Decatur 70, Ill. *Allen Van Wyck*

Illuminating Engineering Co.
2347 E. Nine Mile Road, Hazel Park, Mich.
Bert C. Pretzer

Iowa-Illinois Gas & Electric Co.
United Light Bldg., Davenport, Iowa
John M. Hollingsworth

Iowa Public Service Co.
400 Commercial St., Waterloo, Iowa
C. E. Wagoner

Jeannette Shade & Novelty Co.
N. Fourth St., Jeannette, Pa. *H. N. Crock*

Jefferson Electric Co.
Bellwood, Ill. *L. Mauerer*

Jersey Central Power & Light Co.
501 Grand Ave., Asbury Park, N. J.
Thomas R. Dobson

Joleco Corporation
2513 Baldwin St., St. Louis, Mo.
George Ledbetter

Jones Metal Products Co.
West Lafayette, Ohio *H. Boyer*

Joslyn Mfg. & Supply Co.
3700 So. Morgan St., Chicago 9, Ill.
J. H. Pahoy

Kahn Manufacturing Co., Inc.
2051 N. 19th St., Milwaukee, Wis.
Charles F. Kahn

Kansas City Power & Light Co.
P.O. Box 679, Kansas City 10, Mo.
John M. Arthur, Jr.

Kansas Gas & Electric Co.
P.O. Box 204, Wichita, Kans. *H. W. Hobson*

The Kawneer Co.
North Front St., Niles, Mich.
Richard M. Spray

The Kayline Company
2480 E. 22nd St., Cleveland 15, Ohio
M. A. Eskins

Kelso-Burnett Electric Co.
223 W. Jackson Blvd., Chicago 6, Ill.
Sigmund A. Hollinger

Keystone Electric Manufacturing Co.
2228-36 E. Tioga St., Philadelphia 34, Pa.
Leonard M. Siegel

The Kirlin Company
3435 E. Jefferson Ave., Detroit 7, Mich.
Ivan Kirlin

Kopp Glass, Inc.
Swissvale, Pa. *F. C. Ashe*

Kubec Electric Co.
630 W. Jackson Blvd., Chicago 6, Ill.
Fred A. Girten

The La Salle Lighting Products, Inc.
145 Seneca St., Buffalo 3, N. Y.
Nelson R. Zicherman

Leader Electric Manufacturing Corp.
3500 N. Kedzie St., Chicago 18, Ill.
Walter Glass

The Leeds & Northrup Co.
4901 Stenton Ave., Philadelphia 44, Pa.
I. M. Stein

Libbey Owens Ford Glass Co., Plaskon Division
2112-24 Sylvan Ave., Toledo, Ohio
Dr. M. H. Bigelow

Light Control Company
3217 Casitas Ave., Los Angeles 26, Calif.
Stanley E. Lindahl

Lighting & Lamps
114 East 32nd St., New York 16, N. Y.
James Krieger

Lighting Incorporated
1834 So. Figueroa St., Los Angeles, Calif.
Harry Marsh

Lighting Products, Inc.
2259 W. Park Ave., Highland Park, Ill.
D. E. Dunne

Lightolier Co.
11 East 36th St., New York 16, N. Y.
H. Stollnitz

Line Material Co.
800 North 8th St., Milwaukee 1, Wis.
M. C. Harsh

Litecontrol Corp.
36 Pleasant St., Watertown 72, Mass.
Paul H. Lamson

Louisiana Power & Light Co.
142 Delaronde St., Station "A," New Orleans, La. *C. L. Osterberger*

Luminator, Inc.
120 N. Peoria St., Chicago 7, Ill.
Albert L. Arenberg

T. R. Lyda Manufacturers Rep.
4922 Washington Blvd., Indianapolis, Ind.
T. E. Lyda

Lynn Gas & Electric Co.
90 Exchange St., Lynn, Mass. *James A. Cook*

Macbeth Corp.
227 West 17th St., New York, N. Y.
Norman Macbeth

Malden Electric Co.
157 Pleasant St., Malden, Mass.
Donald S. Bennett

Markel Electric Products, Inc.
145 E. Seneca St., Buffalo 3, N. Y.
D. L. Ripley

La Cie Martineau Electrique Ltee.
24 rue du Roi, Quebec, Canada
Henri Martineau

Metalcraft Products Company
306-08 Cherry St., Philadelphia 6, Pa.
Alex Abel

Metal Window Institute
Cheltenham, Pa. *George Hingston*

Metropolitan Edison Co.
412 Washington St., Reading, Pa.
E. J. Ingram

Metropolitan Electrical Supply Co.
20 N. Jefferson St., Chicago 6, Ill.
H. J. Privat

Midwest Chandelier Co.
15th & Gentry Sts., No. Kansas City 16, Mo.
Sidney Lefkovitz

The Miller Co.
Meriden, Conn. *G. W. Beals*

Mississippi Glass Co.
220 Fifth Ave., New York City 1, N. Y.
E. H. Hobbie

Mississippi Power Co.
Gulfport, Miss. *R. M. Shearer*

Mississippi Power & Light Co.
Lampton Building, Jackson 113, Miss.
Henry B. Sargent

Mitchell Manufacturing Co.
2525 Clybourn Ave., Chicago 14, Ill.
Bernard Mitchell

Mobilite Inc.
440 Mercer St., Jersey City, N. J.
Sidney Solmor

Modern Light Co.
1512 Pine St., St. Louis 3, Mo.
Karl L. Rundberg

Modern Light & Equip. Co.
3812 S. Wabash Ave., Chicago, Ill.
M. L. Ofsenberg

Moe-Bridges Corp.
1415 Illinois Ave., Sheboygan, Wis.
J. G. Rainey

Montana-Dakota Utilities Co.
831 Second Ave. So., Minneapolis 2, Minn.
W. L. Hayes

Municipal Light and Power Dept.
City of Pasadena, California, 302 City Hall, Pasadena 1, Calif. *E. L. Bettannier*

Mutual Sunset Lamp Mfg. Co., Inc.
540 Empire State Bldg., New York 1, N. Y.
Morris Thau

The Narragansett Electric Co.
49 Westminster St., Providence 1, R. I.
C. R. Broadhead

National Chemical & Manufacturing Co. Luminall Paint Div.
3617 So. May St., Chicago 9, Ill.
John Marshall Zic

National Lighting Products
4221 W. Harrison St., Chicago 24, Ill.
D. J. Epp

Nebraska Power Co.
720 Electric Bldg., Omaha 2, Neb.
G. A. Walker

Nelson-Tombacher Co.
81 Prospect St., Brooklyn, N. Y.
M. J. Tombacher

New Bedford Gas & Edison Light Co.
693 Purchase St., New Bedford, Mass
W. S. Fenstermacher

New Orleans Public Service, Inc.
317 Baronne St., New Orleans, La.
S. L. Drumm

New York Power & Light Corp.
Albany 1, N. Y. *Coburn D. Hollister*

Northern Electric Co. Ltd.
1620 Notre Dame St., West, Montreal, Quebec.
F. P. Labey

Northern Indiana Public Service Co. Gary Div.
500 Broadway, Gary, Ind. *J. C. Sackman*

Northern States Power Co.
Minneapolis 2, Minn. *Carl T. Bremicker*

Ohio Edison Co. (Akron Div.)
Akron 8, Ohio *R. F. Hartenstein*

The Ohio Power Co.
301-315 Cleveland Ave., S. W., Canton 2, Ohio
C. B. Morin

The Ohio Public Service Co.
P.O. Box 6058, Cleveland 1, Ohio.
C. L. Dunn

Oklahoma Gas & Electric Co.
Box 1498, Oklahoma City 1, Okla.
E. W. Gray

Omaha Public Power District
720 Electric Bldg., Omaha 2, Nebraska
E. E. Schwalm

Overbagh & Ayres Mfg. Co.
411 S. Clinton St., Chicago 77, Ill.
Alfred A. Overbagh

Pacific Gas & Electric Co.
245 Market St., San Francisco 5, Calif.
O. R. Doerr

Pacific Power & Light Co.
522 Public Service Bldg., Portland 4, Oregon
C. A. Root

Peerless Electric Ltd.
1090 Pratt Ave., Outremont, Quebec.
L. A. Van Duzer

Wm. Penn Fluorescent Light Mfg. Co.
1639 So. Broad St., Philadelphia, Pa.
William Ranieri

Pennsylvania Electric Co.
535 Vine St., Johnstown, Pa.
Frank R. Knowles

Pennsylvania Power Co.
19 E. Washington St., New Castle, Pa.
P. G. Dingledy

Pennsylvania Power & Light Co.
901 Hamilton St., Allentown, Pa.
J. M. Stedman

Pennsylvania Wire Glass Co.
1612 Market St., Philadelphia 3, Pa.
Dr. Frank W. Preston

The Perfeclite Company
1457 E. 40th St., Cleveland, Ohio
Joseph L. Jaffe, Jr.

Philadelphia Electric Co.
1000 Chestnut St., Philadelphia 5, Pa.
H. B. Bryans

Philadelphia Electrical & Mfg. Co.
1200-36 N. 31st St., Philadelphia 21, Pa.
R. A. Manwaring

Phoenix Glass Co.
Monaca, Pa. *D. G. Cameron*

Pierce Electric Co.
367 West Adams St., Chicago 6, Ill.
John H. Pierce

Pittsburgh Corning Corp.
307 Fourth Ave., Pittsburgh, Pa.
Robert W. McKinley

Pittsburgh Plate Glass Co.
Grant Bldg., Pittsburgh 19, Pa.
R. B. Tucker

Pittsburgh Reflector Co.
403-411 Oliver Bldg., Pittsburgh 22, Pa.
H. C. Zinsmeister

Portland General Electric Co.
Electric Bldg., Portland 5, Ore. *T. W. Fitch*

The Potomac Edison Co.
55 E. Washington St., Hagerstown, Md.
S. S. Bradford

Public Service Co. of Colo.
900 Fifteenth St., Denver, Colo. *G. B. Buck*

Public Service Co. of Indiana, Inc.
110 N. Illinois St., Indianapolis 9, Ind.
G. O. Stewart

Public Service Co. of Northern Illinois
72 West Adams St., Chicago 3, Ill.
G. K. Hardacre

Public Service Co. of Oklahoma
Box 201, Tulsa 2, Okla. *C. N. Robinson*

Public Service Electric & Gas Co.
80 Park Place, Newark 2, N. J.
H. P. J. Steinmetz

Puget Sound Power & Light Co.
860 Stuart Bldg., Seattle 11, Wash.
Frank McLaughlin

The Pyle-National Co.
1334 N. Kostner Ave., Chicago 51, Ill.
T. E. McDowell

Quadrangle Mfg. Co.
32 So. Peoria St., Chicago 7, Ill.
Dwight E. Worrell

Quebec Hydro-Electric Commission
107 Craig St., West, Montreal, Que.
Paul E. Poitras

Quebec Power Co.
229 St. Joseph St., Quebec, Que.
Jean Saint-Jacques

Rambusch Decorating Co.
40 W. 13th St., New York 11, N. Y.
Edward Rambusch

Revere Electric Mfg. Co.
6009-17 N. Broadway, Chicago 40, Ill.
Van N. Marker

Revere Electric Supply Co.
757 West Jackson Blvd., Chicago, Ill.
Floyd Pernau

Rochester Gas & Electric Corp.
89 East Ave., Rochester 4, N. Y.
Frank C. Taylor

Rockland Light & Power Co.
Nyack, N. Y. *D. S. Schaab*

Rohm and Haas Co.
222 W. Washington Sq., Philadelphia 5, Pa.
F. W. Tetzlaf

Ruby-Phillite Corp.
32-02 Queens Blvd., Long Island City 1, N. Y.
Louis Phillips

Rumsey Electric Co.
1007 Arch St., Philadelphia 7, Pa.
T. W. Lauer

Ryall Electric Supply Co.
1160 Stout, Denver, Colo. *C. O. Ryall*

S & M Lamp Co.
119 West 36th Place, Los Angeles 54, Calif.
Jim Shirrefs

The Safety Car Heating & Lighting Co.
P.O. Box 904, New Haven 4, Conn.
Leonard Pierson

St. Joseph Ry., Light, Heat & Power Co.
520 Francis St., St. Joseph 3, Mo.
F. P. O'Connor

Sandel Manufacturing Co.
3618 So. Loomis Place, Chicago 9, Ill.
A. L. Sandel

Sandee Manufacturing Co.
5050 Foster Ave., Chicago, Ill.
Cortes N. Sprankle

San Diego Gas & Electric Co.
P.O. Box 1831, San Diego 12, Calif.
A. E. Holloway

Savannah Electric & Power Co.
Savannah, Ga. *J. L. Davidson*

Schockett Electric Co.
1061 Broadway St., Denver 3, Colo.
Carl Schranz, Jr.

Schomer Electric Supply
164 S. Broadway, Aurora, Ill.
Daniel Schomer

The Scott-Jaqua Co. Inc.
316 Indiana Terminal Warehouse Bldg., Indianapolis, Ind. *C. A. Jaqua*

The Albert Sechrist Mfg. Co.
1717 Logan St., Denver 5, Colo.
E. L. Francis

L. J. Segil Co.
2500 W. North Ave., Chicago, Ill.
Louis Rosenstein

Shawinigan Water and Power Co.
600 Dorchester St., W., Montreal, Que.
J. K. Wilson

The Sherwin-Williams Co.
101 Prospect Ave., N. W., Cleveland 1, Ohio
J. A. Meacham

The Sight Light Corp.
P.O. Drawer C, Deep River, Conn.
E. L. Canfield

Silvray Lighting, Inc.
R. K. O. Bldg., Radio City, New York 20, N. Y. *J. M. Gilbert*

Sioux City Gas & Electric Co.
515 Fifth St., Sioux City 4, Iowa *C. R. Tracy*

A. L. Smith Iron Co.
217 Everett Ave., Chelsea, Mass.
Joseph Fishman

Smoot-Holman Co.
321 No. Eucalyptus Ave., Inglewood, Calif.
L. A. Hobbs

Sola Electric Co.
4633 W. 16th St., Chicago 50, Ill.
L. C. Marschall

Solar Light Mfg. Co.
1357 S. Jefferson St., Chicago 7, Ill.
A. Lazerson

The Solex Co. Ltd.
280 Faillon St., West, Montreal, Que.
Leon Beauchamp

Southern Calif. Edison Co., Ltd.
601 West 5th St., Los Angeles 53, Calif.
G. M. Rankin

Southern Canada Power Co. Ltd.
355 James St., West, Montreal, Que.
George E. Atchinson

Southern Colorado Power Co.
Box 75, Pueblo, Colo.
G. W. Milliken

Southern Indiana Gas & Elec. Co.
P.O. Box 569, Evansville 3, Ind.
C. K. Graham

Southern Lighting Mfg. Co.
P.O. Box 2546, Orlando, Fla.
Max K. Aulick

Southwestern Gas & Elec. Co.
Box 1106, Shreveport, La.
J. E. Elliott

Southwestern Public Service Co.
Amarillo, Texas
J. E. Cunningham

Sperti Electric Mfg. Corp.
Beech & Kenilworth Aves., Norwood, Ohio
Ralph A. Lostro

The Spero Electrical Corp.
18222 Lanken Ave., Cleveland, Ohio
Herbert I. Spero

Stanley Electric Mfg. Co.
1234 Carpenter St., Philadelphia 47, Pa.
Bernard S. Heller

Stober Manufacturing Co.
2700 Roosevelt Rd., Broadview, Maywood, Ill.
T. L. D. Lynxwiler

Steiner Electric Co.
3500 Milwaukee Ave., Chicago 41, Ill.
George S. Steiner

Sterling Reflector & Mfg. Co.
3249 West Grand Ave., Chicago 51, Ill.
Anton Oberhuber

Sunbeam Lighting Co.
777 E. 14th Place, Los Angeles 11, Calif.
Herbert L. Krieger

Sun-Ray Fluorescent Co.
600 South Michigan Ave., Chicago, Ill.
Jerome Gimbel

Sylvania Electric Products, Inc.
500 5th Ave., New York, N. Y.
D. P. Caverly

Tampa Electric Co.
Cass & Tampa Sts., Tampa 1, Fl.
F. J. Gannon

Texas Electric Service Co.
Electric Bldg., Fort Worth 1, Texas
R. E. Hendricks

Thompson Electric Co.
1101 Power Ave. N. E., Cleveland 14, Ohio
Thayer B. Farrington

Toledo Edison Co.
Edison Bldg., Toledo 4, Ohio
Charles A. Harrison

Toronto Hydro-Electric System
14 Carlton St., Toronto 2, Ont.
A. W. J. Stewart

Torstenson Glass Co.
3233 N. Sheffield Ave., Chicago 13, Ill.
Elmer L. Torstenson

Triangle Industries
600 W. Adams St., Chicago, Ill.
Leonard Cohen

Tru-Lite Ltd.
824 Notre Dame St., W., Montreal, Que.
Omer M. Trudel

Underwriters' Laboratories, Inc.
207 E. Ohio St., Chicago 11, Ill.
Ferd. Neumer

Union Electric Co. of Missouri
12th & Locust Sts., St. Louis 1, Mo.
W. L. Berry

Union Metal Mfg. Co.
Canton 5, Ohio *W. A. Porterfield*

The United Illuminating Co.
80 Temple St., New Haven 6, Conn.
E. B. Haskell

United Manufacturing Co.
Div. United Advertising Corp.
190 Whalley Ave., New Haven, Conn.
William R. Harris

Utah Power & Light Co.
Box 899, Salt Lake City 10, Utah
W. A. Huckins

Verd-A-Ray Corp.
615 Front St., Toledo 5, Ohio *O. S. Levi*

John C. Virden Co.
6009-6103 Longfellow Ave., Cleveland 3, Ohio
W. G. Sawyer

John C. Virden, Ltd.
35 Front St., East, Toronto, Ont.
P. G. Kirkpatrick

Virginia Electric & Power Co.
Richmond, Va. *J. G. Holtzclaw*

Voigt Co.
1649 No. Broad St., Philadelphia 22, Pa.
C. J. Frank

The F. W. Wakefield Brass Co.
Vermilion, Ohio *A. F. Wakefield*

The Washington Water Power Co.
P.O. Drawer 1445, Spokane 6, Wash.
Carl L. Hoffman

The Watson Standard Co.
225 Galveston Ave., Pittsburgh 12, Pa.
H. E. Striker

The Welsbach Corp.
1500 Walnut St., Philadelphia 2, Pa.
H. H. Adams

Westchester Lighting Co.
9 South 1st Ave., Mt. Vernon, N. Y.

Westinghouse Electric Corp.
1216 W. 58th St., Cleveland 1, Ohio (P.O. Box 5817) *W. F. White*

Westinghouse Electric Supply Co.
113 North May St., Chicago 7, Ill.
Henry Czech

Westinghouse Lamp Div.
Bloomfield, N. J. *Samuel G. Hibben*

West Penn Power Co.
14 Wood St., Pittsburgh 30, Pa.
Harry Restofski

The Wheeler Insulated Wire Co., Inc.
150 E. Aurora St., Waterbury 91, Conn.
George B. Horn

Wheeler Reflector Co.
275 Congress St., Boston 10, Mass.
K. A. Sawin

Wiedenback-Brown Co., Inc.
111 Eighth Ave., New York 11, N. Y.
W. C. Stockberger

R. & W. Wiley, Inc.
119 Dearborn St., Buffalo 7, N. Y.
H. B. Alderman

H. B. Williams Products Co.
108 S. Main St., Carthage, Mo.
F. B. Williams, Jr.

Wilmot Castle Co.
1255 University Ave., Rochester 7, N. Y.
E. H. Greppin

J. A. Wilson Lighting & Display Ltd.
9 Morrison St., Toronto, Ont. *J. A. Wilson*

The Windsor Utilities Comm., Hydro Div.
149 Chatham St., W., Windsor, Ont.
W. A. Shaw

The Wiremold Company
Hartford 10, Conn. *D. Hayes Murphy*

Wisconsin Electric Power Co.
Public Service Bldg., Milwaukee 1, Wis.
G. W. Van Derzee

Wisconsin Gas & Elec. Co.
100 Third St., Racine, Wis. *J. H. Dunham*

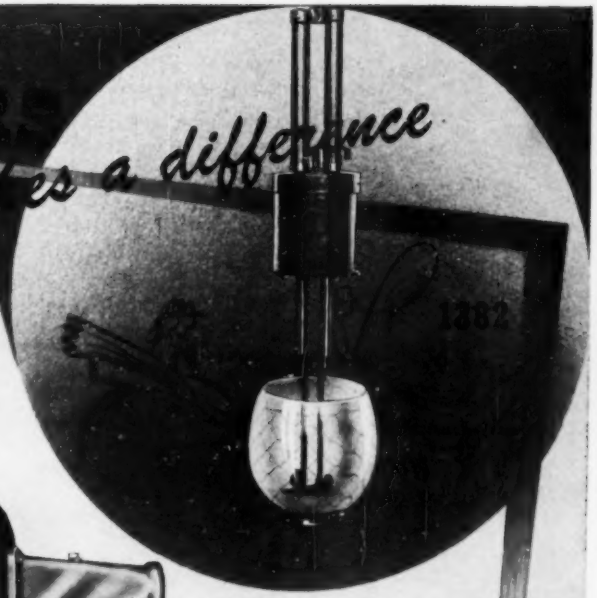
Wisconsin Power & Light Co.
122 W. Washington Ave., Madison 1, Wis.
J. D. Howard

Wisconsin Public Service Corp.
Green Bay, Wis. *A. G. Bur*

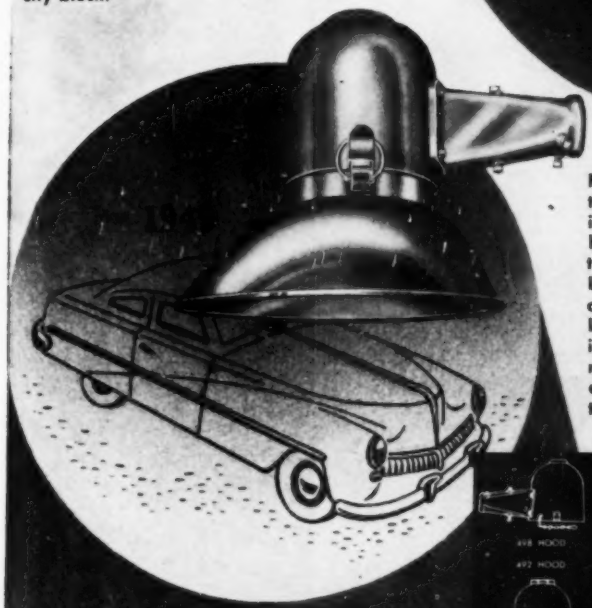
Worcester County Electric Co.
11 Foster St., Worcester, Mass.
Fred E. Littlefield

Yonkers Electric Light & Power Co.
9 South 1st Ave., Mt. Vernon, N. Y.

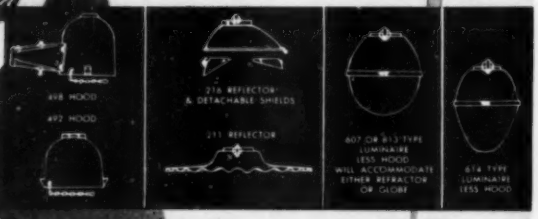
67 YEARS makes a difference



PEMCO, a pioneer in the manufacture of Street and Highway Lighting Equipment, today enjoys the position of being the oldest Street Lighting manufacturer in America operating under its original name and management. Since its organization in 1882 PEMCO has grown from a small one story building to a modern plant which now covers practically an entire city block.



From the days of the carbon arc light down through the years of the evolution of modern incandescent Street Lighting Fixtures, PEMCO has borne its share of the responsibility for the progress of Street Lighting. PEMCO Luminaire No. 306 (illustrated) is an example of the latest development in modern Street Lighting. Detachable reflector and shields, interchangeable on a variety of hood styles, make these Luminaires economical to install and maintain. Careful engineering guarantees maximum efficiency.


#18 HOOD
#92 HOOD
216 REFLECTOR & DETACHABLE SHIELDS
211 REFLECTOR
607 OR 613 TYPE LUMINAIRE LESS HOOD WILL ACCOMMODATE EITHER REFRACTOR OR GLOBE
674 TYPE LUMINAIRE LESS HOOD

For information on PEMCO's complete line of Street and Highway Lighting Equipment request PEMCO General Catalog No. 50.

PEMCO

Low-cost upkeep and replacement is paramount in modern Street Lighting practice. Interchangeable parts not only lessen the need for warehousing large stocks of maintenance equipment, but simplify changeover from one type of luminaire to another. Long-range planning with PEMCO Interchangeable Luminaires will pay big dividends in reduced future costs.

PHILADELPHIA ELECTRICAL & MFG. CO.

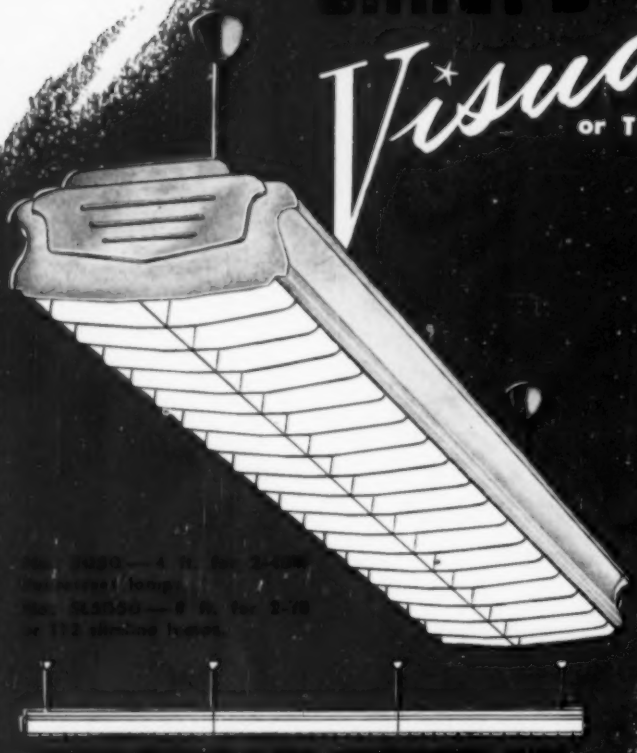
1200-36 N. 31ST STREET, PHILADELPHIA 21, PA.

SALES OFFICES IN PRINCIPAL CITIES

GARCY'S

Visualier

T12 SLIMLINE
or T12 FLUORESCENT



45° SHIELDING
Both longitudinal and transverse.

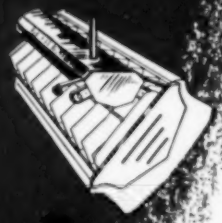
78% LIGHTING EFFICIENCY
By laboratory test.

LOW SURFACE BRIGHTNESS
Engineered for uniform low brightness on all fixture surfaces.

LOW BRIGHTNESS CONTRAST
90% of fixture surface illuminated! Widespread light on ceiling! No dark areas! No objectionable contrast!

50-50 LIGHT DISTRIBUTION
Half direct and half indirect.

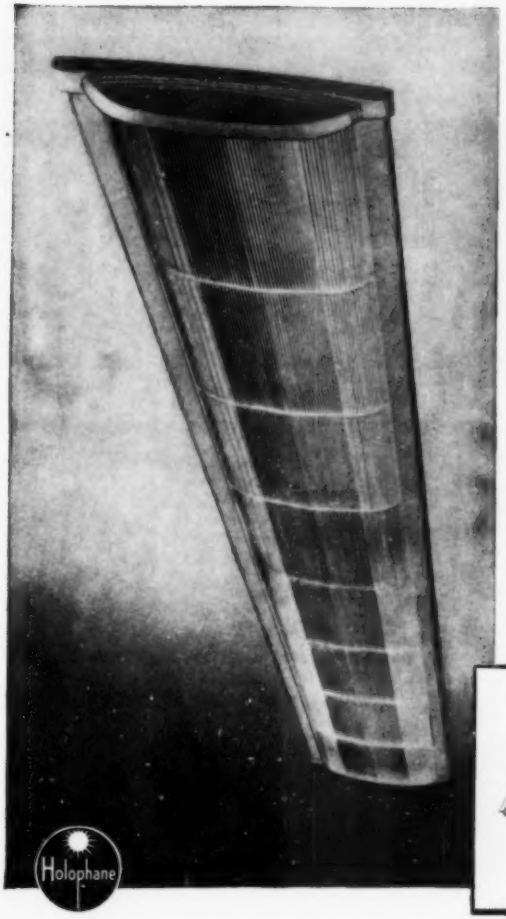
ALUMINUM OR WHITE
Choice of baked white enamel or "Garzal" matte processed aluminum.



PRESERVE TWENTY-TWENTY SIGHT
WITH GARCY
FIFTY-FIFTY LIGHT

Write For Detailed Literature

GARDEN CITY PLATING & MFG. CO.
1760 N. ASHLAND AVE. — CHICAGO 22, ILL.



NEW HOLOPHANE CONTROLENS*

NO. 9200

Takes the GLARE out of FLUORESCENT LIGHTING

Holophane research presents an entirely new concept of light control with this new CONTROLENS. Adding *LENGTHWISE* control to crosswise control of light, it affords the utmost in visibility, comfort, economy . . . Efficiency inherent in fluorescent lamps can only be retained by scientific control of light which *cuts off* glare while *building up* light on the work. New CONTROLENS No. 9200 is as attractive as it is efficient. The lens is remarkably light in weight despite its great strength and resistance to breakage. Unit constructions are diversified to allow full planning freedom as to installation methods, lamp capacity, and switching arrangements.

Write for Interesting Brochure and engineering data on New CONTROLENS development

*Reg. U. S. Pat. Off.

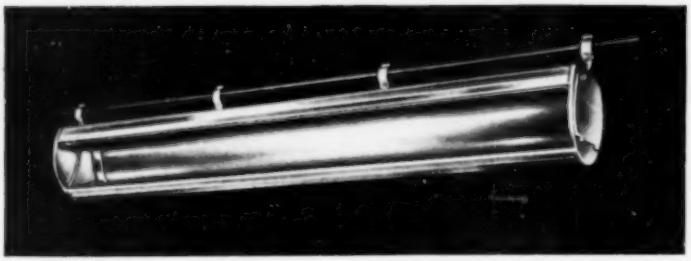
HOLOPHANE COMPANY, INC.

Lighting Authorities Since 1898 • 342 MADISON AVENUE, NEW YORK 17, N.Y.

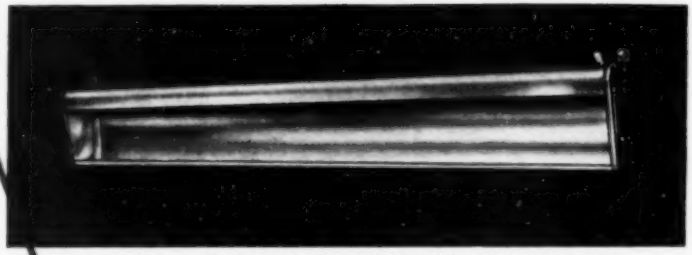
THE HOLOPHANE COMPANY, LTD., THE QUEENSWAY, TORONTO 14, ONTARIO

★ The Entire Holophane Organization Sends Congratulations to All Who Attend the I.E.S. Conference ★

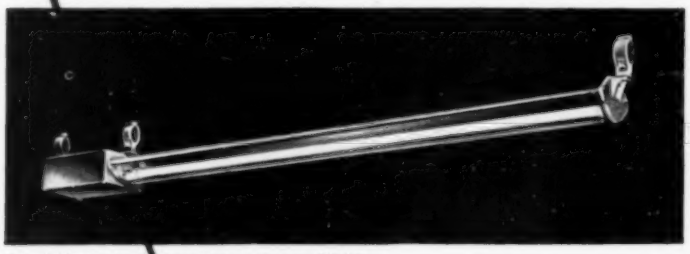
what's **New** in street lighting



Form 200 Luminaire for arterial lighting



Form 201 Luminaire for continuous-strip fence-height lighting of bridges, viaducts, roadways approaching airports and similar applications



Form 202 Luminaire for continuous-strip tunnel lighting

Another Achievement of General Electric Engineering

This is the first line of fluorescent luminaires optically designed for roadway lighting.

Fluorescent Luminaires for Roadway Lighting

Fluorescent Roadway Lighting as we see it —

Fluorescent lighting of streets has been successfully used in England; but its applications in the United States has been delayed for several obvious reasons. Weather and traffic conditions, installation problems, and maintenance costs differ greatly in the two countries.

Lighting authorities acknowledge that certain inherent advantages of the fluorescent light source should not be overlooked in the constant search for more and better roadway lighting. General Electric engineers fully realize that the use of fluorescent roadway lighting in this country, on a large scale, can come only after a thorough investigation and study of actual installations. This calls for the close cooperation of designers, utilities, and municipalities.

IMPORTANT ADVANTAGES OF FLUORESCENT

The fluorescent lamp is characterized by long life and high efficiency. The inherently low brightness of the fluorescent luminaire compared with that of any conventional luminaire having similar lumen output is an important factor in eye comfort. The extremely broad pattern of pavement brightness between the driver and the luminaire makes it outstandingly worthy of development and use in pioneer installations. The apparent light source of the new Form 200 luminaires has an area of 6 square feet compared with the conventional luminaire's area of ½ to ⅔ square feet. This should result in a new and higher degree of "comfortable seeing."

OBSTACLES TO BE OVERCOME

The use of fluorescent luminaires for roadway lighting entails new mounting and installation methods. The effect of low temperature on light output presents a problem which must be further overcome before the full inherent economies of fluorescent as used indoors can be realized in all outdoor applications.

OUR OBJECTIVE

It is with the full knowledge of the foregoing characteristics that engineers of the Illuminating Laboratory of General Electric's Outdoor Lighting Center at Lynn, Massachusetts, present this new line of luminaires for roadway lighting.

These luminaires are optically correct for their intended applications. They combine all that has been learned by engineers who developed the fluorescent lamp and by men of long experience in the design of street-lighting equipment.

It is hoped that leaders in the outdoor lighting industry will want to pioneer in this new field through developmental installations and thus help advance the progress of fluorescent lighting out of doors.

A General Electric Street-lighting Specialist is available to work with you. Ask your G-E apparatus sales engineer. Get in touch with him today. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

The Form 200 Luminaire for pole mounting will provide good visibility and Comfortable Seeing with modern practice in mounting height and spacing. Laterally, the distribution of light will be broad. Vertically, the main beam is directed outward at a high enough angle to provide good illumination and high pavement brightness between luminaires. The brightness of the luminaire at angles as seen by the motorist is low, providing Comfortable Seeing.

The Form 201 Parapet Luminaire is designed for use primarily where poles are objectionable or impractical. The luminaire is mounted at the driver's eye level and will produce good pavement brightness with complete shielding of the light source.

The Form 202 Luminaire is designed for use in tunnels or under-passes and may be mounted to provide continuous ribbons of low brightness light which produce excellent silhouette visibility.

GENERAL ELECTRIC

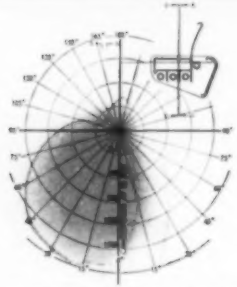
452-98

...perfect lighting for modern merchandising!

KENT-MOORE VAL-LITES

What a difference VAL-LITES make in modern retail store lighting! First, they're good looking fixtures . . . smartly styled as attractive "tailored" valances that provide radiant diffused illumination all around the wall sales area. Second, VAL-LITE'S distribution of candlepower has been engineered to create distinctively lighted displays that dramatize merchandise, catch and hold customer attention. And finally, with easy-to-change, easy-to-read individual letters, VAL-LITES permit effective "point-of-purchase" advertising and provide efficient means of department identification to direct store traffic.

So next time you're planning a retail store lighting system, emphasize *"sales appeal"* with Kent-Moore VAL-LITES. Quickly, easily installed in either single or multiple unit application. Available in models for two or four 40-watt fluorescent lamps. Sturdily built, union made, approved by Underwriters'. Write for complete details today.



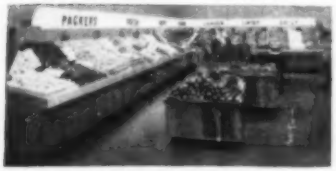
Candlepower Distribution Chart for VAL-LITE Model J-1817 equipped with four 40-watt fluorescent lamps.

Kent-Moore

ORGANIZATION, INC.

GENERAL MOTORS BUILDING • DETROIT 2, MICHIGAN

VAL-LITES BUILD SALES FOR YOU AND YOUR CUSTOMERS



Kent-Moore VAL-LITES are a "natural" for super markets. Merchandise sparkles, and customers can find it fast.

Brand names stand out against VAL-LITE backlighting while appliances below make a "buy-appealing" display.

This automobile dealer increased mechanic efficiency by lighting and labeling his service department car stalls.

Ease of Installation

IS A FEATURE OF *Wakefield* LIGHTING EQUIPMENT

Almost like hanging a picture . . .

Everything hooks on to pre-installed straps . . .

A one-man job . . .

The secret is the pre-installed strap. First step is to secure a mounting strap to the outlet box. Next run a chalk line along the ceiling, measure off the required intervals and then attach the other mounting straps in the line. The easily assembled units are then hung on the mounting straps, unit by unit, the supporting band on the previously mounted unit providing the reflector support for the end of the next unit. A steel channel insures rigidity for the wireway, and snap-on wireway covers give accessibility for wiring. Writes one power company engineer: "Contractors have been vociferous in their praise of the ease with which they were able to install your fixtures."

1. Fully Guaranteed
2. A.F. of L. Labels
3. Underwriters Approved
4. Certified Ballasts

Catalog No. 50 just off the press—write for your copy!

Wakefield Over-ALL Lighting

I.E.S. PUBLICATIONS

IMPORTANT for your lighting reference bookshelf. Items are numbered for identification with coupon below.

★

(1) I.E.S. LIGHTING HANDBOOK

One volume, 850 pages. A complete reference guide providing basic information on all phases of lighting. For architects, designers, engineers and others who plan, install and manufacture lighting systems and equipment. $7.50 per copy; $5 in lots of 10 or more.

I.E.S. Members who have not availed themselves of the privilege of one membership copy at $5 may still do so. Add 50 cents if for shipment abroad.

★

AMERICAN STANDARD AND RECOMMENDED PRACTICES

(2) SCHOOL LIGHTING. American Standard Practice.

Newest American Standard Practice for help in planning, selling, installing and maintaining lighting quality in schools.

(3) HOME LIGHTING Recommended Practice

(4) OFFICE LIGHTING Recommended Practice

(5) LIGHTING PRACTICES FOR STORES AND OTHER MERCHANDISING AREAS

(6) STREET AND HIGHWAY LIGHTING. American Standard Practice.

Booklets above available at 50 cents per copy or in quantity as follows: First 4 copies, 50 cents each; next 20, 25 cents each; all over 24 copies, 15 cents each.

(7) INDUSTRIAL LIGHTING. American Recommended Practice.

One to 10 copies, 25 cents each; next 40, 20 cents each; over 50, 15 cents each.

LIGHTING DATA SHEETS

Actual lighting installations fully illustrated, covering such subjects as lighting for the metalworking, textile, automobile and other industries, as well as lighting for stores, offices and residences. Sheets punched for standard binders.

(8) Series 11 through 13. Available at $1 per series.

(9) NEW SERIES XIV!

Subscribe now for the new Series I.E.S. Lighting Data Sheets, the latest information available on a wide variety of lighting installations, bringing up to date the information carried in earlier series. New Series is already widely in use by public utility companies and manufacturers as well as individuals to make their own reference data current and for distributing to customers. First seven sheets now available; balance shipped during year to subscribers. Subscription, $1.25; $1.00 in lots of 25 or more.

(10) SPECIAL DATA SHEET BINDER

New style, durable loose-leaf binder bound in blue fabrikoid and attractively stamped in gold. Single binder, $1.50; in lots of 25 or more, $1.25.

LIGHTING COURSE MATERIAL

(11) Experiments with Light, for science students, 25 cents each.

(12) Fundamentals of Illumination (outline), $1.00 each; 10 or more, 75 cents.

(13) Lessons in Practical Home Illumination (outline), 25 cents each.

(14) Lighting Design Problems Course (outline), $1.50; 10 or more $1.25.

OTHER PUBLICATIONS

(15) Testing Procedures for Illumination Characteristics. Five committee reports in one volume combining guides to testing of fluorescent lamps and luminaires, and street lighting luminaires. Per copy, $1.00.

(16) Art Gallery Lighting, 50 cents per copy up to four; next 20, 25 cents; over 24, 15 cents.

(17) Standard Method for Measuring and Reporting Illumination from Artificial Sources in Building Interiors, 10 cents each.

(18) Lighting Performance Recommendations for Portable and Installed Residence Luminaries, 50 cents each.

★

(19) Residential Wiring Design Handbook, 25 cents each.

(20) Farmstead Wiring Design Handbook, 40 cents each.

(Published by Industry Committee on Interior Wiring Design, Room 2650, 420 Lexington Ave., New York, N. Y. Quantity prices on application.)

Indicate publications wanted by number. Enter name and address. Clip out and mail.

9

ILLUMINATING ENGINEERING SOCIETY
51 Madison Avenue
New York 10, New York

Date _____

Please send me, addressed as below, copies of I.E.S. Publications which I have indicated by number.

☐ My check (money order) is enclosed. ☐ Bill me.

_____ copies ☐
_____ copies ☐
_____ copies ☐
_____ copies ☐
_____ copies ☐

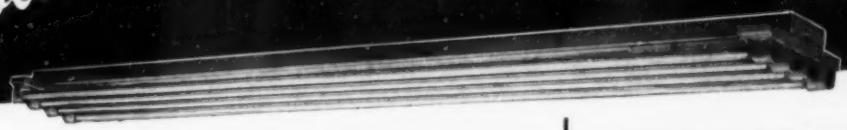
Name _____

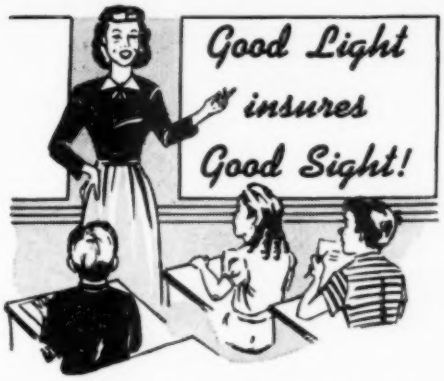
Company _____

Street _____

City _____ Zone _____ State _____

Cold Cathode
— the magic words in School Lighting!





ONLY *Cold Cathode* offers

- Lowest Glare (No louvres or glass diffusers required)
- No starters (Number of starts do not affect lamp life)
- Long Life (Up to 10 years of uninterrupted light)
- Big Maintenance Savings
- Stroboscopic At Its Lowest
- No Flickering

Not Affected By Humidity Or Freezing Temperatures

ONLY *Colonial*

The world's foremost developers and manufacturers of Cold Cathode Lamps and Fixtures produce School Lighting equipment that embodies all of the above features.

THERE IS NO COMPROMISE FOR SCHOOLS THAT DEMAND A HIGH "EYE-QI"*

**EYE QUOTIENT*

The rating of lighting efficiency on a basis of eye conservation, clarity and comfort.

Schools throughout the nation that are present users of Colonial Cold Cathode Lighting have written to us and praised the remarkable efficiency, the long lamp life and the minimum maintenance requirements that they have been experiencing every day with our products.

These testimonials supplement similar experiences in major industrial and commercial installations that have been in operation, in many instances, for ten or more years. Such nationally famous companies and institutions as General Motors, Western Electric, Bakelite Co., Wright - Aeronautical, Port of N. Y. Authority, Serial Savings Bank, United States Fidelity and Guaranty Co., Public Utilities, etc., are listed among Colonial's satisfied customers.

Write to our Engineering Department today for further details and for free lighting analyses and layouts of your classroom lighting requirements. There is no obligation, of course.

COLONIAL ELECTRIC
PRODUCTS, INCORPORATED
EAST PATERSON, NEW JERSEY

LOUVERLITE

SLIMLINE

by Smithcraft

A PROGRESSIVE DEVELOPMENT IN LOUVERED LIGHTING

A FOLDER "LOUVERLITE SLIMLINE" IS AVAILABLE UPON REQUEST. WRITE FOR YOUR COPY TODAY!

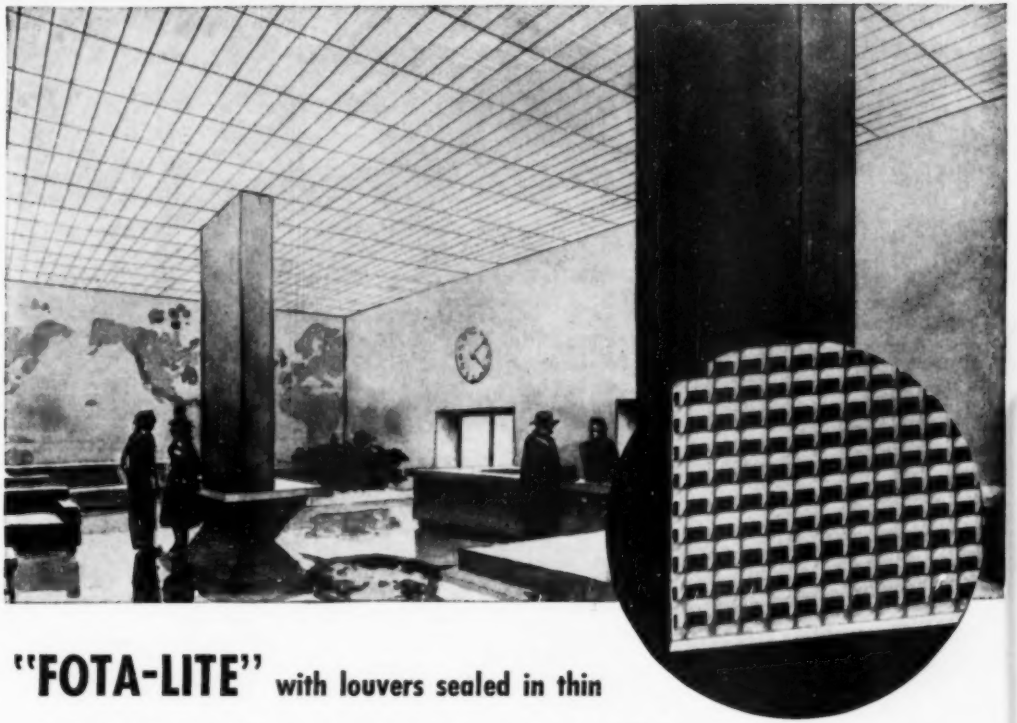
Smithcraft
LIGHTING DIVISION
CHELSEA 50, MASSACHUSETTS

Louverlite Slimline, truly a progressive development in louvered lighting, utilizes the Smithcraft "area-of-light source" principle to create an extremely shallow and unobtrusive fixture. Designed for two or four T-12 or T-8 96" Slimline lamps, Louverlite Slimline provides an excellent downward component of glare-free light, with an effective louver cut-off of 30° crosswise, 30° lengthwise.

Louverlite Slimline may be mounted surface or pendant, individually or continuous row. Installation and maintenance are effectively simplified. The rigid louver is held by Smithcraft Duo-Cam hangers, and relamping can be easily accomplished by finger-tip release of the louver, from a single position. For servicing, the louver hinges from either side and can be removed without involving tools or loose parts.

Louverlite Slimline is a notable achievement in the design of fluorescent lighting elements . . . a proud addition to the Smithcraft line of "America's finest fluorescent fixtures".

SOMETHING NEW IN HIGH LEVEL ILLUMINATION!



"FOTA-LITE" with louvers sealed in thin smooth glass, gives you a clean, dust-tight installation

"FOTA-LITE," Corning's newest lighting glassware, is designed for efficient high level illumination. Instead of bulky, hard to clean materials, you control light distribution with louvers *sealed in a thin panel* of glass. Thus, fixtures can be made shallower and dust-tight. The smooth surface of "Fota-Lite" can be wiped clean quickly. Original efficiency remains unimpaired.

Due to a cell size many times smaller than conventional louvering materials, this glass, in a fixture, has the appearance of plain opal. However, light directed vertically passes almost unrestricted through the clear sections.

Strong, light in weight, free of warpage and available in standard or special patterns, "Fota-Lite" combines many advantages which radically improve louver panel lighting. It is also non-color selective, important in maintaining true color values. Ask for Bulletin LS-19.

LOUVERED GLASS FOR MODERN LIGHTING—A NEW LOUVERING MATERIAL

CORNING GLASS
PYREX

CORNING GLASS WORKS
Lighting Sales Department
Corning, New York

SALES OFFICES:
New York
Chicago
San Francisco

CORNING GLASS WORKS, DEPT. IE9, CORNING, N. Y.

Please send Bulletin LS-19, describing Fota-Lite.

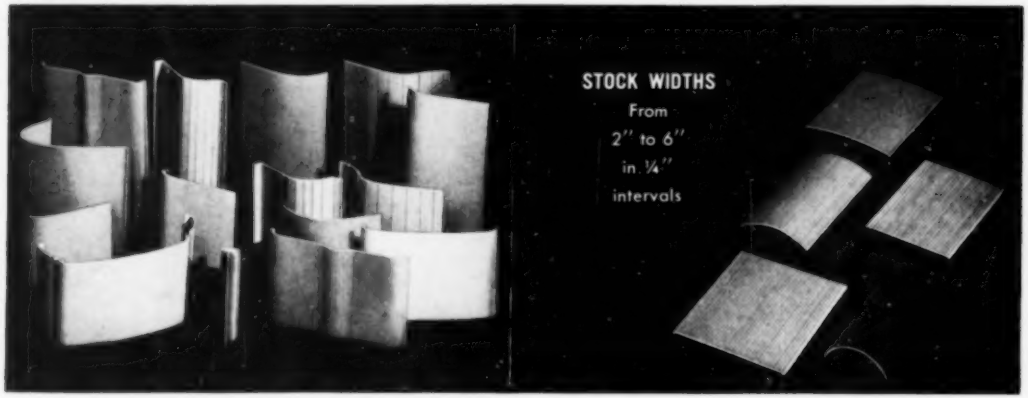
NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

HOW TO *IMPROVE* FLUORESCENT LIGHTING FIXTURES *and Cut Costs, too!*



CUSTOM SIDE PANEL SECTIONS

Custom POLY-LITE side and bottom panels or sections in ever increasing sizes and intricacy of shape are made to close tolerance specifications. Widths up to 15 inches have been produced. We can extrude larger sizes successfully in the newly developed light stabilized material and ship in lengths cut to your requirements.

STOCK SIDE PANEL SECTIONS

Stock POLY-LITE sections of finest quality are now available at surprisingly low cost! Widths from 2 to 6 inches (measured flat) in ¼ inch increments are manufactured without tool charge. They are produced flat or curved to uniform radius in clear or translucent white color.

Finer Quality at Lower Cost!

POLY-LITE extruded panels are used or specified by manufacturers, contractors and electricians everywhere. You, too, can take advantage of their light weight, safety, easy installation and maintenance. Sandee gives experienced engineering and design counsel, proper material selection and accurate, economical production. Manufacture of panels in the exact specified thickness is essential for proper strength, service durability and light transmittance. It is Sandee's policy to recommend only a section of sufficient weight to satisfactorily do the job required of it. Quotations are based only on blueprint or drawing approved by customers, with guaranteed delivery of full weight section and continuous production according to blueprint and quotation.

Years of extrusion experience, plus our integrity and proven ability are your assurance of top quality, fair price, and successful application of our POLY-LITE panels. Write for additional information on controlled light transmittance, excellent dimensional stability and cost cutting features. Suggestions, ideas, samples, and estimates without cost or obligation.

Sandee Manufacturing Company **5050 FOSTER AVENUE, CHICAGO 30, ILLINOIS**

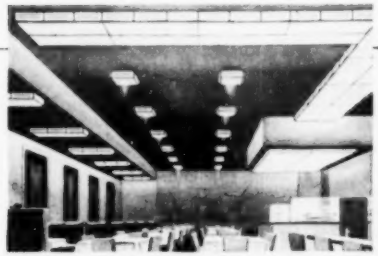
SALES REPRESENTATIVES IN NINETEEN PRINCIPAL CITIES

"WORLD'S LARGEST CUSTOM EXTRUDERS OF PLASTICS"

"POLY-LITE"®

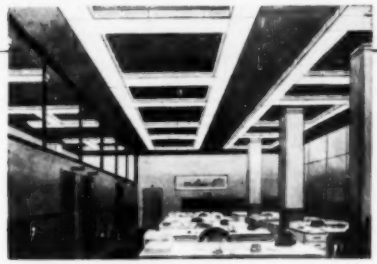
EXTRUDED POLYSTYRENE SIDE SHIELDS BY SANDEE

☆ makes possible limitless pattern designs



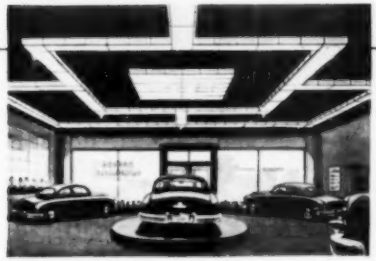
☆ custom-fits any room shape or proportions

the revolutionary
new idea in lighting



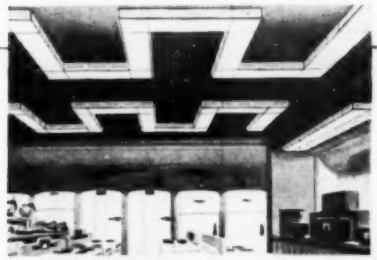
☆ provides unlimited linear flexibility

MITCHELL
module
REG. U.S. PAT. OFFICE



☆ mixes many light sources in one uniform system

the **custom-fitting**
lighting system



☆ features equal low brightness throughout

Write today for free 20-page MODULE brochure which gives every detail of this exciting new lighting development. Use coupon below.

☆ provides harmonious matched appearance throughout

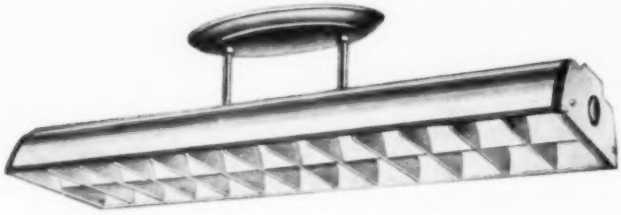
MITCHELL MANUFACTURING COMPANY
2525 Clybourn Avenue, Chicago 14, Illinois
Send full details on MITCHELL MODULE

Firm Name .....

Address .....

City ..... Zone ..... State .....

GILL *planned lighting luminaries*



A softly luminous direct-indirect pendant luminaire with curved glass side reflectors—for use in Schoolrooms, Offices and other areas for high efficiencies and comfortable low brightnesses.

Certified FLEUR-O-LIER
CERTIFIED
in accordance with Test Requirements of Specifications of Fluor-O-Lier Manufacturers

Catalog No. 324

• For use with 2-40 watt fluorescent lamps.

COMPLETELY VERSATILE . . .

- Available for use with two or four regular, T-8 or T-12 slimline, fluorescent lamps.
- Lamps shielded to 37° crosswise and 25° lengthwise—or 45° both ways.
- With or without top reflector plates.
- Stem or surface-mounted, singly or in a continuous row.

EASY TO MAINTAIN . . .

• ONE-STEP DISMANTLING TO CLEAN

The side reflectors and the bottom louver assembly can be easily and quickly removed for cleaning—no tools necessary.

The curved glass side panels provide a permanent luminous effect—will not discolor, warp, or shrink

• STARTERS

Semi-recessed in wiring channel—can be serviced without disturbing lamps or other parts of the luminaire.

Write for Catalog #50 giving specifications and showing the complete Planned Lighting line of GILL fluorescent and incandescent luminaires, troffers, and downlighting units.

GILL GLASS and FIXTURE COMPANY

established 1875

Amber & Tioga Streets **Philadelphia**

General Electric announces a new kind of 3-lite lamp!

NEW G-E LAMP HAS THREE GREAT ADVANTAGES:

1. ***DELUXE-WHITE FINISH* for near perfect light diffusion!**
2. ***CHOICE OF THREE BRIGHTNESS LEVELS*—50, 100, or 150-watts!**
3. ***NEW INDIRECT-LITE SHAPE* for pleasing balance of upward and downward light!**

Here's General Electric's new 3-lite lamp bulb, designed for the high-volume, economy-priced lamp business! At the New York and Chicago lamp shows more than seventy portable lamp manufacturers featured table and junior-size floor lamps for this new bulb!

Just look at its sales-making advantages—exceptional light diffusion, balanced upward and downward light, choice of brightness levels.

The new 3-lite bulb is another example of the General Electric lamp research that works constantly to make *G-E lamps Stay Brighter Longer.*

You can put your confidence in—

GENERAL ELECTRIC

Continued from page 578

Lighting Stunts, by Robert Carson, *Lighting and Lamps*, July 1949, p. 23

Sportswear Shop Has Spirit of the Out-of-Doors, by Seymour R. Joseph, *Lighting and Lamps*, July, 1949, p. 30

Lighting for Safety, Convenience, Comfort in New Stove Company Plant, *Lighting and Lamps*, July, 1949, p. 38

Decoralite—A Versatile Lighting Device, by Meyer Loebelson, *Lamp Journal*, July, 1949, p. 41

Optimum Performance of High-Brightness Carbon Arcs, by M. T. Jones and F. T. Bowditch, *Journal of the Society of Motion Picture Engineers*, April, 1949, p. 395

Effect of Carbon Cooling on High-Current Arcs, by Wolfgang Finkelnburg, *Journal of the Society of Motion Picture Engineering*, April, 1949, p. 407

An Objective High Speed Photographic Technique for Simultaneously Recording Changes in Accommodation and Convergence, by Merrill J. Allen, *American Journal of Optometry and Archives of American Academy of Optometry*, July, 1949, p. 279

Techniques Nouvelles Dans Le Chauffage Des Usines Et Des Grands Locaux, *La Technique Moderne*, Juin 15, 1949, p. 177

Les Tubes Luminescents, *La Technique Moderne*, Juin 15, 1949, p 184

Relighting at the Cincinnati Gas & Electric Company, *Lighting and Lamps*, June, 1949, p. 27

Manual of Lighting Fixture Design, by Edwin D. Tillson, *Lighting and Lamps*, June 1949, p. 32

Store Planning and Lighting, by William T. Snaith, *Lighting and Lamps*, June, 1949, p. 41

Lighting a Powerful Factor in Merchandising and Architecture, by Adolph Novak, *Lighting and Lamps*, June, 1949, p. 44

Trends in Store Lighting, *Lighting and Lamps*, June, 1949, p. 47

Modernization Transforms Kenedy's, *Lighting and Lamps*, June, 1949, p. 50

Warm Color Fluorescent Adopted for Macy's Newest Branch Stores, by Richard G. Belcher, *Lighting and Lamps*, June, 1949, p. 52

Lighting of the Broadway Crenshaw, *Lighting and Lamps*, June, 1949, p. 54

Packaged Sunshine, *The Magazine of Light*, Vol. 18, No. 2, p. 6

Spotlighting Fashions, *The Magazine of Light*, Vol. 18, No. 2, p. 12

Goodbye Interference!, *Magazine of Light*, Vol. 18, No. 2, 1949, p. 30

A Note on the Photo-Pupil Reflex, by Jules De Launay, *Journal of the Optical Society of America*, May, 1949, p. 364

The Spherical Aberration of the Eye, by M. Koomen, R. Tousey and R. Scolnik, *Journal of the Optical Society of America*, May, 1949, p. 370

Comparison of Color Systems with Respect to Uniform Visual Spacing, by Robert W. Burnham, *Journal of the Optical Society of America*, May, 1949, p. 387

Modern Church Lighting, *I.E.S. Lighting Review*, February, 1949, p. 12

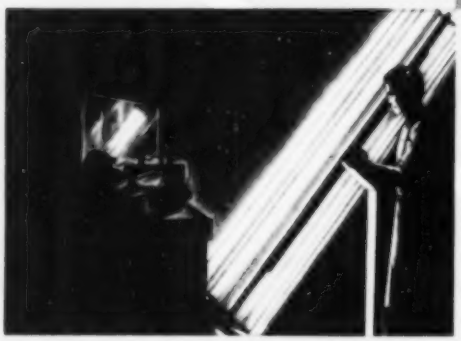
Les Seuils Differentiels De Couleurs Dans La Theorie De Young, *Revue D'Optique*, Mai, 1949, p. 5

New Fluorescent Bulletin Fascinates All Chicago, by J. C. Heath, *Signs of the Times*, June, 1949, p. 31

FLUORESCENT LUMINAIRES BACKED BY RESEARCH

SUNBEAM LIGHTING COMPANY

727 E. 14TH PL., LOS ANGELES 21, CALIF.



The advanced illumination engineering and photometric research behind the design and production of SUNBEAM luminaires is reflected in the complete variety of fixture types available for today's commercial and industrial lighting needs. The detailed consideration and effort made to achieve specific types of light distribution, efficiency, ease of installation and maintenance for these installations are the basic reasons for the ever-increasing demand for SUNBEAM lighting equipment.

For further information, write for Sunbeam's catalog No. 12.

A Story on Cold Cathode Fluorescent Lighting, Part IV, *Signs of the Times*, June, 1949, p. 69

Atmosphere Lighting with Cold Cathode, *Signs of the Times*, June, 1949, p. 74

Beryllium Poisoning, by Robert J. Hasterlik, *Physics Today*, June, 1949, p. 14

Notes on Fluorescent Lamps, by R. G. Slauer, *Electrical World*, June 4, 1949, p. 94

School House Lighting, by H. M. White, *Electrical South*, May, 1949, p. 32

Building for Athletics and Recreation, *Architectural Record*, July, 1949, p. 116

Ultraviolet Air Sanitation, by L. J. Buttolph, *Architectural Record*, July, 1949, p. 139

Lighting and Architecture, by Abe Feder, *Display World*, May, 1949, p. 74

Bases para la Formulacion de un Codigo de la Luz, *Revista Electrotecnica*, Marzo, 1949, p. 131

Custom Lighting for a Woolen Mill, *Electrified Industry*, June, 1949, p. 24

Light for Playing Fields, by Jerrell R. Powell, *Electrical South*, June, 1949, p. 22

Planned Maintenance, by L. H. Houck, *Electrical South*, June, 1949, p. 26

Light It to Sell It, by Harrie H. Bierman, *Electrical South*, June, 1949, p. 64

The Trend to Plastics, by F. W. Tetzlaff, *Chicago Electric News*, June, 1949, p. 6

The Lighting of Churches, by L. C. Rettig, *Transactions of the Illuminating Engineering Society*, Volume XIV, No. 5, 1949, p. 117

Some Notes on Flameproof Lighting and Power Installations, by Stanley L. Lyons, *Light and Lighting*, May, 1949, p. 116

Colour Matching, *Light and Lighting*, May, 1949, p. 122

Spectrophotometry, *Light and Lighting*, May, 1949, p. 125

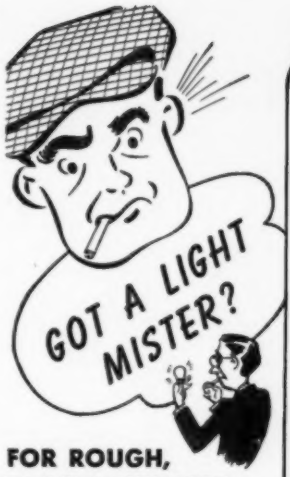
Television Studio Lighting, *Light and Lighting*, May, 1949, p. 134

The Measurement of Daylight, *Electric Light and Power*, May, 1949, p. S6

The Daylighting of Factories, by J. B. Bickerdike, *Building and Engineering*, February 24, 1949, p. 33

The Stability of "Improvement" in

Continued on page 22A



FOR ROUGH, TOUGH SERVICE?

HERE'S WHERE YOU WANT REAL CHAMPION PERFORMANCE

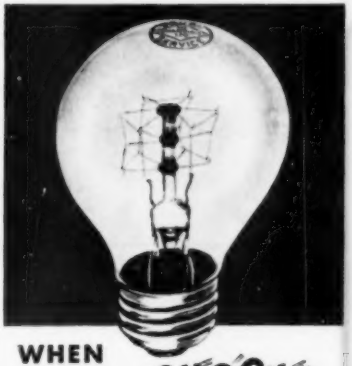
ASK YOUR INDUSTRIAL OR ELECTRICAL SUPPLY HOUSE for these CHAMPION Special Service Lamps, or ask us to put you in touch with the supplier nearest you.

CHAMPION LAMP WORKS
Lynn, Massachusetts

A DIVISION OF CONSOLIDATED ELECTRIC LAMP CO.

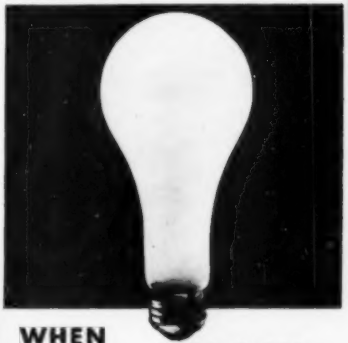
WHEN THERE'S VIBRATION

CHAMPION *Vibration Service* Lamps are specially engineered and constructed with filament mounting and super flexible filament entirely different from that of ordinary lamps. They stand up under severe and sustained vibration.



WHEN THERE'S SHOCK

CHAMPION *Rough Service* Lamps are just what the doctor ordered for locations subject to sudden shocks or bumps, as when used with extension cords. As many as sixteen scientifically designed supports cushion the filament.



WHEN THERE'S SPLASH

CHAMPION *Hard Glass* Lamps are specially designed for locations exposed to weather, moisture or splashing.

This new instant start Slimline
INDUSTRO-LITE is just one of many Smoot-Holman
developments in the field of lighting
— 425 ma. with more lumens per foot.

Offices in Principal Western Cities • Branch and Warehouse in San Francisco

Continued from page 21A

Color Vision Due to Training — A Report of Three Cases, *American Journal of Optometry and Archives of American Academy of Optometry*, Vol. 26, No. 6, June, 1949, p. 251

Lighting Specialists, by Harrie H. Bierman, *Electrical South*, July, 1949, p. 18

Glare-Free Lighting Methods Studied by M.I.T., by H. L. Beckwith, C. M. F. Peterson and Parry Moon, *Architectural Record*, June, 1949, p. 145

A Comparison of Electrical and Psychophysical Determinations of the Spectral Sensitivity of the Human Eye, by Lorrin A. Riggs, Richard N. Berry, and Matthew Wayner, *Journal of the Optical Society of America*, June, 1949, p. 427

Measurement of the Influence of Local Adaptation on Color Matching, by David L. MacAdam, *Journal of the Optical Society of America*, June, 1949, p. 454

Colorimetry by Abridged Spectrophotometry, by Arthur C. Hardy and F. Mansfield Young, *Journal of the Optical Society of America*, June, 1949, p. 460

Visibility on Cathode - Ray Tube Screens, The Effect of Size and Shape of Pip, by N. R. Bartlett, S. B. Williams and R. M. Hanes, *Journal of the Optical Society of America*, June, 1949, p. 463

Visibility on Cathode - Ray Tube Screens; Signals on a P-7 Screen Exposed for Different Intervals, by N. R. Bartlett and A. L. Sweet, *Journal of the Optical Society of America*, June, 1949, p. 470

The Measurement of Light and Colour, by G. T. Winch, *The Proceedings of The Institution of Electrical Engineers*, June, 1949, p. 452

Modern Trends in Room Lighting, by H. L. Beckwith, C. M. F. Peterson, Parry Moon, *Electrical Engineering*, July, 1949, p. 577

Ultimos adelantos en illuminacion de calles en Londres, by L. T. Minchin, *Revista Electrotecnica*, Mayo, 1949, p. 228

Additions to the Squantum School, *American School Board Journal*, July, 1949, p. 33

Decrease Eye Fatigue in Shop Meter Testing, by R. A. Macomb, *Electrical World*, July 2, 1949, p. 80

How McKeesport Planned Modern School Lighting, by Dr. Leo R.

Continued on page 24A

When you sharpen your pencil, remember—

THERE ARE FOUR PRICES

ON EVERY LIGHTING UNIT YOU BUY

The PRICE of Quality

FRINK fluorescent lighting units deliver *more quality* dollar-for-dollar. Better materials, superior craftsmanship, more efficient design cost you less in the long run.

The PRICE of Installation

You *save on installation* with FRINK units because they come fully assembled, ready for mounting in minimum time.

The PRICE of Maintenance

FRINK fixtures are famous for *lower maintenance cost.* Easier, faster cleaning and lamp replacement yield you important savings through the years.

The PRICE of Satisfaction

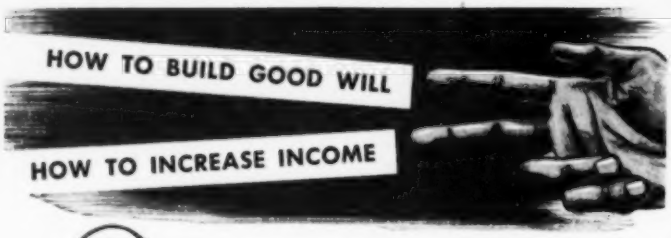
FRINK *guarantees* each unit to be engineered for complete lighting satisfaction. Dependability of performance is backed to the limit by our 92 year old reputation. With FRINK, you're *sure!*

Your copy of the new Frink L-I-N-O-L-I-T-E Catalog is ready. Send for it today.

PLANNED LIGHTING FRINK SINCE 1897

THE FRINK CORPORATION

27-01 Bridge Plaza North, Long Island City, N.Y.

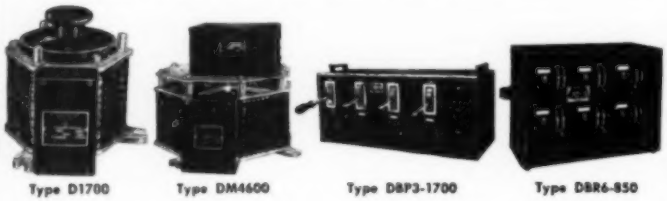


2 TIMELY TIPS . . .

1. A theatre equipped with modern, flexible lighting facilities can build good will and increase income through added off-hour use. Either by conversion, or by incorporating these facilities in new structures, any movie house can, in its off-hours, double as a place of assembly for a wide variety of community affairs, charity drives, rallies, lodges, clubs, open forums and similar events.

2. Civic meetings, conventions and even church services during off-show hours can add revenue and local stature — especially to theatres in suburbs, neighborhoods and small communities which cannot ordinarily afford civic auditoriums used only a few days a month. The use of theatres for such purposes can prove economical to sponsoring groups and profitable to theatre ownership and management.

POWERSTAT Light Dimming Equipment can help make any theatre suitable for these off-hour uses. With it, stage or houselights can be brightened, blended or dimmed to suit the occasion. It is easy and economical to install and operate. And it's dependable — built to withstand constant use and to give years of trouble-free service.



Type D1700 Type DM4600 Type DBP3-1700 Type DBR6-850

POWERSTAT Dimmers are designed for manual or motor-driven operation, for direct or remote, pushbutton control.

We'll be glad to send complete information on how **POWERSTAT** Dimmers can be used in your theatre. Write us today.

WRITE 5099 DEMERS AVENUE, BRISTOL, CONNECTICUT

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

POWERSTAT VARIABLE TRANSFORMERS • VOLTBOX A-C POWER SUPPLIES • STABILINE VOLTAGE REGULATORS

Continued from page 22A

Travis, *Better Light, Better Sight News*, Volume 17, Number 1, p. 2

Thoughts on 1949 School Design by William Arild Johnson, *Better Light Better Sight News*, Volume 17, No. 1, p. 4

Lions Club Gets Action on Local and State School Needs, *Better Light Better Sight News*, Vol. 17, No. 1, p. 8

Let's Work Together for Better School Lighting, by C. C. Shotwell, *Better Light Better Sight News*, Vol. 17, No. 1, p. 11

New Jersey Experimental Classroom Features Easy Seeing, *Better Light Better Sight News*, Vol. 17, No. 1, p. 12

Lighting for Television, *Better Light Better Sight News*, Vol. 17, No. 1, p. 13

Straatverlichting met Fluorescentielampen, by Dr. D. Vermeulen, J. B. Boer, *Electro-Techniek*, 12 Mei, 1949, No. 10, p. 167

Transport Lighting with Fluorescent Lamps, by H. R. Ruff, J. N. Hull and R. V. Mills, *Building and Engineering*, March 24, 1949, p. 84

Terrace Plaza of Cincinnati, by Arthur E. Bertke, *Electrical Construction and Maintenance*, April, 1949, p. 65

Industrial Kitchen, by Hugh P. Scott, *Electrical Construction and Maintenance*, April, 1949, p. 65

Industrial Kitchen, by Hugh P. Scott, *Electrical Construction and Maintenance*, April, 1949, p. 78

Harvard Relights Baker Library, by John A. Bernard, *Electrical Construction and Maintenance*, April, 1949, p. 80

Area Control of Plant Lighting, *Electrical Construction and Maintenance*, April, 1949, p. 91

Louverall Ceilings Light Classrooms, *Electrical Construction and Maintenance*, April, 1949, p. 135

Selected Details, School—Skylighting, *Progressive Architecture*, May, 1949, p. 105

Jewelry Store Lighting Techniques, by B. C. Cooper, *Electrical Construction and Maintenance*, June, 1949, p. 62

Down and Cross Lighting for Church Illumination, *Electrical Construction and Maintenance*, June, 1949, p. 117

Louverall Lighting for Billiards, *Electrical Construction and Maintenance*, June 1949, p. 122

CHECK LIST of **BALLAST** *Performance*

for . . . Architects

Compare **these facts about the**

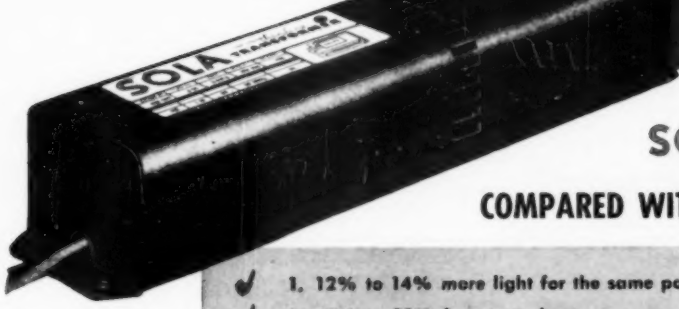
SOLA "75"

CONSTANT WATTAGE FLUORESCENT BALLAST

FOR TWO T12 96" SLIMLINE LAMPS

Fixture Manufacturers and

Users of FLUORESCENT FIXTURES



SOLA "75"

COMPARED WITH ORDINARY BALLASTS*

1. 12% to 14% *more* light for the same power cost!
2. 47% to 52% *less* watts loss!
3. Maintains constant light output with primary voltage range from 95-130 volts.
4. Weighs only 11 pounds – 42% to 52% less than competitive makes. Reduces fixture weight, cuts shipping costs and installation expense!
5. Less heat rise *externally* and *internally* – By Resistance 12%-40% less –By Thermocouple 12%-24% less. Reduces air conditioning costs and prolongs ballast life.
6. Ventilated capacitor compartment is 42% cooler!
7. Small size permits installation in standard slimline channels!
8. Designed to conform with specifications of leading lamp manufacturers.

*Tests made July, 1949 on competitive products.

SPECIFY "SOLA BALLASTS" FOR ALL FLUORESCENT FIXTURES AND REDUCE INSTALLATION AND *MAINTENANCE* COSTS

SOLA *Constant Wattage* BALLASTS

An application of the famous SOLA Constant Voltage Principal which made transformer history in the electric field!

Write for your copy of the Free SOLA "75" Bulletin.

Transformers for: Constant Voltage • Cold Cathode Lighting • Airport Lighting • Series Lighting • Fluorescent Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal System • etc. • **SOLA ELECTRIC COMPANY, 4633 W. 16th Street, Chicago 50, Illinois**

New Day-Brite Four-by-Four Unit Wins High Acclaim

Architects, lighting engineers and contractors, and users have enthusiastically approved Day-Brite's new Four-by-Four Unit. Unlimited architectural possibilities, flexibility of application, and advanced integrated lighting efficiency are only a few of the reasons for a wave of orders.

FOR OFFICES

Four-by-Four Units are engineered for both recessed and surface mounted applications. Plaster frames are available for use when fixtures are recessed.

LARGE DEPARTMENT STORES

Units are 48" square and 9" deep. Fixtures can be used with six, eight, or ten 40-watt fluorescent lamps. Knockouts are provided for feed connections.

ENTRANCES, LOBBIES

Exclusive Day-Brite BOXCO louver assembly has double-wall louvers interlocked for extreme strength and rigidity. Fixtures are rust-inhibited and finished in HOT-BONDED SUPER-WHITE enamel.

SMALL RETAIL STORES

Separable hinges on two sides of the louver assembly allow easy servicing. In fact, every component part of the unit is *specifically* engineered for simple, quick maintenance.

Alameda Road Shop, Singer Sewing Machine Company, Kansas City, Mo.

For example:

SINGER SEWING MACHINE IN KANSAS CITY "DRESSES UP" WITH FOUR-BY-FOURS . . .

Day-Brite Four-by-Four units, recessed into an acoustical ceiling provide a high level of cool, glareless light in Singer's Alameda Road Shop.

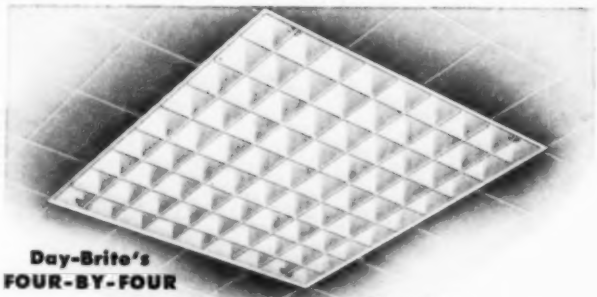
This well-distributed general lighting combines with accent lighting to point up merchandise to best advantage. Architecturally, the ceiling pattern is interesting but unobtrusive . . . attractive and smart.

Today . . . learn more about this new lighting development, its handsome appearance . . . its amazing ease of maintenance. See for yourself how Day-Brite's Four-by-Fours answer your particular lighting problem. Write now for Bulletin 20-C.

Day-Brite Lighting, Inc., 5432 Bulwer Avenue, St. Louis 7, Mo. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.

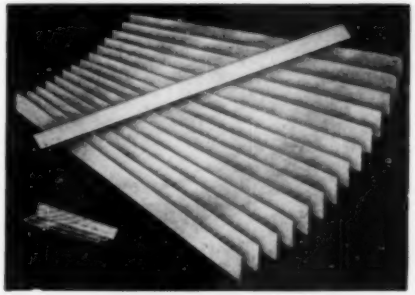
IT'S EASY TO SEE WHEN IT'S
DAY-BRITE *Lighting*

DISTRIBUTED NATIONALLY BY LEADING ELECTRICAL WHOLESALERS



setting a new trend in lighting . . .

359



GLASS FOR FLUORESCENT LIGHTING

In glass processing like everything else, experience, "know how," good deliveries, and modern production equipment is important. These factors are yours at Dearborn.

Flat glass or bent, plain or figured—coated in white ceramic. Glass circles are also bent to convex shapes in any size up to 22" in diameter, clear, figured or in ceramic colors.

Our modern equipment controls the application of the ceramic coating so carefully that the desired density, light transmission and uniformity is assured.

We welcome glass processing problems. Submit blueprints or samples for our recommendation and quotation.

"If it starts with flat glass — we make it"

DEARBORN Glass Company

2400-44 W. 21st STREET CHICAGO 8, ILLINOIS

ACME ELECTRIC
BALLASTS help sell

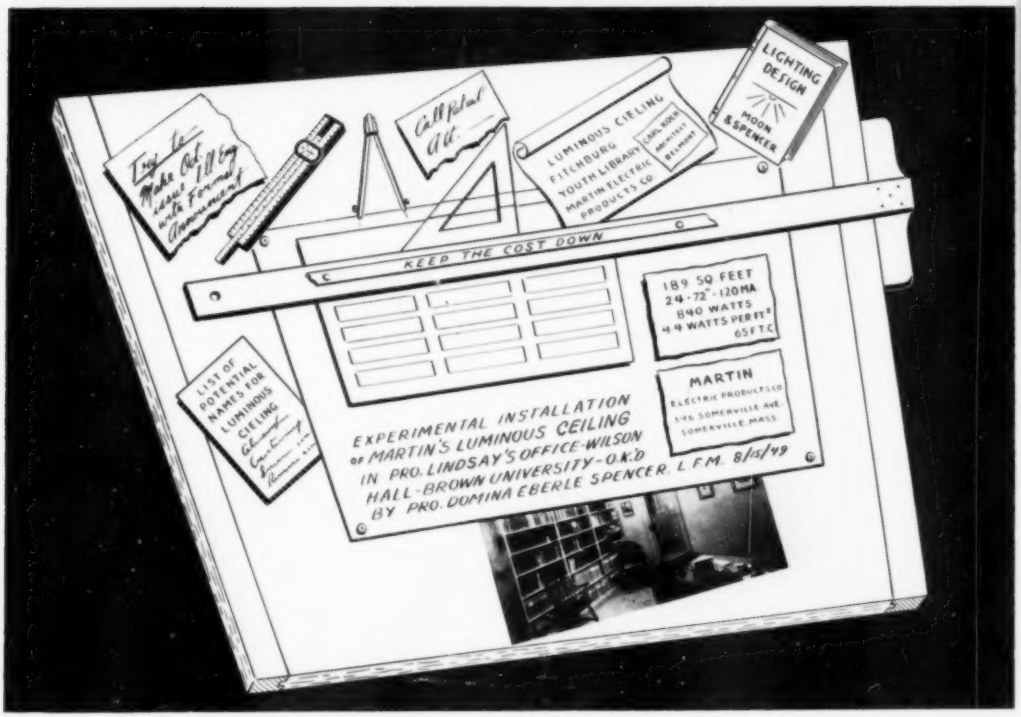
THE BETTER DESIGN AND PERFORMANCE OF MODERN FLUORESCENT FIXTURES

Fluorescent fixture salesmen know that no "alibi" is good enough to satisfy the customer who has purchased a humming fixture, caused by a bee-hive ballast, or who must constantly reseat lamps that flicker or replace black ended lamps. The easiest way to sell good fixtures is to install Acme Electric Ballasts and let the performance show for itself. Designed to provide full rated watt output, maximum light output of lamps, no flickering, no strobe effect, maximum lamp life and quiet fixtures. Test Acme Ballasts and compare their performance.

ACME ELECTRIC CORPORATION

299 WATER STREET CUBA, N. Y.

Acme Electric



NEW GUTH MAZELITE*

hook-on reflector.....
and those Turret Sockets are dandies, too!

That rugged reflector can take it because its GUTH 300° WHITE PERMALUX finish is high-baked to bonderized, zinc-coated steel—*can't* crack, check, chip, craze or peel. Gives over 85% light reflectivity, too!

No more tugs-o'-war trying to remove stubborn reflectors for cleaning! No nuts, clips or gimmicks to get lost or out of order! Mazelite hook-on Reflectors hinge from either side of channel or can be completely removed and replaced instantly.

The new MAZELITE's TURRET SOCKETS speed relampings. Lamps cannot work loose. We'll gladly send you our handy new Pocket Catalog 46A-1 with full details about this and other outstanding lighting equipment—compliments of

YOUR TEAMMATE
in *precision-planned* LIGHTING

Guth LIGHTING

THE EDWIN F. GUTH COMPANY / ST. LOUIS 3, MISSOURI

Leader in Lighting since 1902

013

SALES REPRESENTATIVE

Required for the following states: Ohio, Virginia, North Carolina, South Carolina, Georgia, and Florida. Several openings in these territories are available for men who have had experience in the sale of lighting equipment to distributors. We manufacture a complete line of fluorescent and incandescent lighting equipment and are licensed by the Holophane Co. to fabricate a complete line of lens equipment. Representatives must have a thorough knowledge of the lighting field and be prepared to call upon architects as well as distributors.

GENERAL LIGHTING PRODUCTS CO.
16 Delancy Street, Newark, New Jersey
Phone Mitchell 3-7230

ENGINEER WANTED

Growing midwest manufacturer requires a lighting engineer with a minimum of five years of experience in design of street lighting equipment. Must have a working knowledge of lighting fundamentals with ability to conduct complete photometric tests. Man selected must be capable of carrying on his work with a minimum of supervision. Position permanent. Applications will be held in strictest confidence. Please include complete information and recent photograph. Address Box 112, Illuminating Engineering Society, Publications Office, 51 Madison Ave., New York 10, N. Y.

need special fixtures?

• • •

CALL US

. . . it will save you headaches.

Throughout the lighting industry *Sterling* is synonymous with "*Special Fixtures*". When standard units will not fill the job requirements, a brief session with *Sterling's* staff will assure a completely satisfactory and reasonably priced installation.

STERLING

Reflector & Mfg. Co.

3429 W. GRAND AVENUE, CHICAGO
Phone: SAC 2-6830

INDEX TO ADVERTISERS

September, 1949

Acme Electric Corp.	27A
Benjamin Electric Mfg. Co.	Inside Front Cover
Champion Lamp Works	21A
Colonial Electric Products, Inc.	13A
Corning Glass Works	15A
Curtis Lighting Inc.	4A
Day-Brite Lighting Inc.	26A
Dearborn Glass Company	27A
Fleur-O-Lier Mfrs.	Inside Back Cover
Frink Corp.	23A
Garden City Pltg. & Mfg. Co.	6A
General Electric Co., Apparatus	8A-9A
General Electric Co., Lamp	19A
Gill Glass & Fixture Co.	18A
Edwin F. Guth Co.	28A
Holophane Co., Inc.	7A
Kent-Moore Organization Inc.	10A
Litecontrol Corp.	2A
Martin Electric Products Co.	27A
Mitchell Mfg. Co.	17A
Multi Electrical Mfg. Co.	29A
Pa. Wire Glass Co.	29A
Philadelphia Electrical & Mfg. Co.	5A
Photo Research Corp.	29A
Rohm & Haas Co., Plastics Division	30A
Sandee Mfg. Co.	16A
Smithcraft Lighting Div.	14A
Smoot-Holman Co.	22A
Sola Electric Co.	25A
Sterling Reflector & Mfg. Co.	28A
Sunbeam Lighting Co.	20A
Superior Electric Co.	24A
F. W. Wakefield Brass Co.	11A
Westinghouse Electric Corp., Lamps	Back Cover
Westinghouse Electric Corp., Lighting	1A

ORIGINAL
in its design and manufacture,
SOLID
Corrugated Glass is a product rightfully characterized by its qualities of strength and durability. The application of
CORRUGATED
Glass to various types of installations requiring additional illumination, as well as a modern, cheerful appearance, is a pleasant discovery to those unacquainted with a structural
GLASS
of this design.
Manufactured by
Pennslyvania Wire Glass Company
1612 Market Street Phila. 3, Pa.

for COLOR MATCHING ANALYSING CONTROL

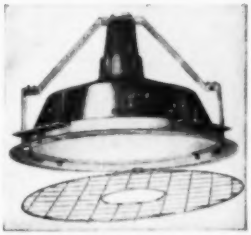
The first precise instrument for measuring the quality (color temperature) of the illumination on the subject and making constant light standards possible is the

SPECTRA

There's a money-saving and quality-improving application of the use of SPECTRA in your industry. Send today for complete descriptive literature and prices.

PHOTO RESEARCH CORPORATION
13024 Devonshire Street, San Fernando, California

FROM ABOVE OR BELOW—



THIS MULTI GYMNASIUM FIXTURE IS ENGINEERED to facilitate servicing from either above or below suspended ceiling. Two thumb screws hold detachable saddle permitting reflector to be removed up through plaster ring. Threaded neck of reflector permits easy removal from below. Catalog No. 3088 with hinged wire guard covers the entire unit. Ready to install.

OUR NEW BULLETIN $ DESCRIBES OTHER FIXTURES FOR GYMNASIUM AND SWIMMING POOL LIGHTING.

Distributed Through Leading Wholesalers

Participating Member RLM Institute

MULTI ELECTRICAL MFG. CO.
4223-43 WEST LAKE ST. CHICAGO 24

A total of 1100 square feet of corrugated white translucent PLEXIGLAS *covers the entire ceiling of the elevator foyer and entrance lobby of the Central National Bank, Cleveland, Ohio. Use of 47½" x 48" x .125" sheets of the acrylic plastic results in over-all, glare-free, completely diffused illumination.*

WALL-TO-WALL LIGHTING FIXTURES OF PLEXIGLAS

Customers leave their shadows at the door of Cleveland's Central National Bank. PLEXIGLAS wall-to-wall lighting fixtures in lobby and elevator foyer diffuse light so perfectly that glare and shadows simply vanish. Light-absorption is negligible, and the result is better lighting with lower electrical input.

IT'S LIGHT . . . IT'S SAFE

At the same time, the lightness and shatter-resistance of PLEXIGLAS assure safety overhead. This acrylic plastic has 7 times the impact strength of glass, yet weighs less than half as much. Large, light sections can be installed easily at reasonable cost, and because PLEXIGLAS resists discoloration—even from fluorescent lighting—maintenance expense is low.

COVERS LARGE AREAS

More and more architects are using PLEXIGLAS fixtures for superior lighting, especially over large areas in offices and public buildings. Its availability in large sheet sizes, corrugated, patterned, or smooth-surfaced—and the ease with which it can be formed into shaped panels and fixtures—permit its use in highly distinctive functional and decorative lighting.

For wall-to-wall lighting fixtures, coffer panels, reflectors, shields, cove lighting fixtures—wherever optimum illumination with no direct or reflected glare is desired—get full details of PLEXIGLAS. We'll be glad to send you complete information.

PLEXIGLAS is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.

Canadian Distributor: Crystal Glass & Plastics, Ltd., 282 St. Helens Avenue, Toronto, Ont.

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

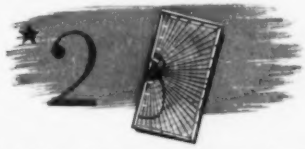
Representatives in principal foreign countries

Only FLEUR-O-LIER gives ALL these advantages:

- ★ Fleur-O-Lier Index System Rating
- ★ Photometric Data
- ★ Coefficients of Utilization Charts
- ★ Certification

MORE AND MORE architects, utility lighting men and contractors are recommending Fleur-O-Lier labeled fixtures because only with Fleur-O-Lier certified fixtures do they get *all* "the facts of light" that enable them to get the most fixtures for their money.

Every Fleur-O-Lier fixture is rated on the Fleur-O-Lier Index System to show its tested illuminating performance.

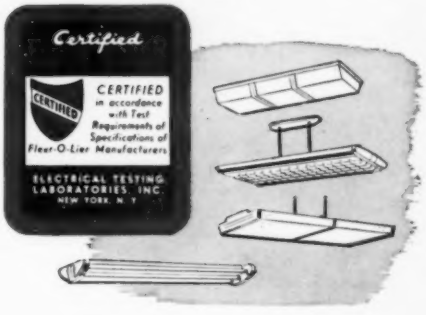


Complete photometric data, as found by Electrical Testing Laboratories, Inc., is provided.

Coefficients of utilization charts, compiled by Electrical Testing Laboratories, Inc., enable the buyer to select the most suitable fixture for his installation.

Certification, backed by Electrical Testing Laboratories, Inc., tests, is the buyer's assurance that the fixtures were made to rigid specifications covering electrical and mechanical features.

Specifiers and buyers are now insisting, "Be sure the fixtures bear the Fleur-O-Lier label!"


Certified
CERTIFIED
CERTIFIED in accordance with Test Requirements of Specifications of Fleur-O-Lier Manufacturers
ELECTRICAL TESTING LABORATORIES, INC.
NEW YORK, N. Y.

FLEUR·O·LIER

Manufacturers

2116 Keith Building • Cleveland 15, Ohio

Fleur-O-Lier is not the name of an individual manufacturer, but of a group of fixtures made by leading manufacturers. Participation in the Fleur-O-Lier program is open to any manufacturer who complies with Fleur-O-Lier requirements.

NEW! FLUORESCENT Sun Lamps

A TOTALLY NEW APPROACH TO THE HUGE "SUN" MARKET

Here is a new business opportunity which offers immediate extra sales . . . and one with future sales potentials so favorable that, as yet, only the broad outlines can be sketched.

The Westinghouse fluorescent sun lamp makes possible, for the first time, a practical and economical means for bathing wide areas with beneficial ultraviolet rays. This means that everyone may now be offered all the Vitamin D-creating benefits of ultraviolet . . . right while they work or play indoors.

Compared with the conventional bulb-type sun lamp, this new fluorescent lamp is cool in operation, and has five times the output and ten times the life. In addition, it costs less to buy, less to run, and fits standard fluorescent fixtures. Consequently, it is practical for homes, factories, schools, offices, bowling alleys, and animal husbandry applications—to name just a few. Besides being ideal for wide-area application, it is excellent for suntanning. This advantage makes it especially attractive for use in hospitals, barber and beauty shops, solaria, gymnasia, and even home bathrooms.

Unquestionably, there is a vastly broadened market opened up by this new fluorescent sun lamp. Cash in on the opportunity! Write for further details. Address: Lamp Division, Westinghouse Electric Corporation, Bloomfield, N. J.

TECHNICAL DATA

	20-WATT LAMP	40-WATT LAMP
Bulb diameter	1½"	1½"
Lamp Length	24"	48"
Operating amperes	0.36	0.415
Operating volts	60	106
Base	Medium Bipin	Medium Bipin
List Price	$4.50	$7.00
Rated Avg. Life	2500 hours at 3 hours per start 4000 hours at 6 hours per start 5000 applications at 15 minutes per start	

YOU CAN BE SURE...IF IT'S Westinghouse